Knowledge & Scientific News

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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

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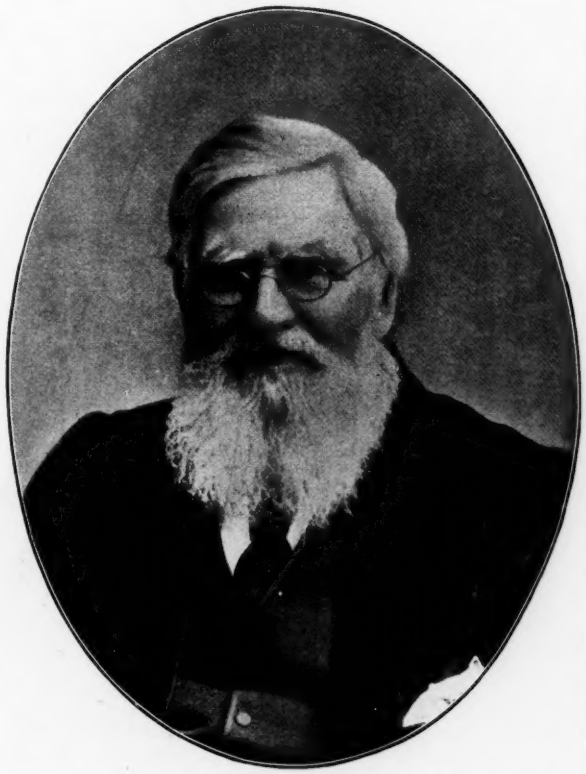
Dr. Alfred Russel Wallace.
An Octogenarian's Birthday.

ON the 8th of last month, Dr. Alfred Russel Wallace, F.R.S., the famous naturalist, whose name is linked with that of Charles Darwin as joint discoverer of the doctrine of natural selection, celebrated his eighty-fifth birthday. We are sure that readers of "KNOWLEDGE" will desire to extend to him their sincere congratulations upon the auspicious event, coupled with the hope that many years of useful life will yet fall to the lot of this distinguished veteran.



DR. ALFRED RUSSEL WALLACE.

It scarcely needs to be recalled, even to those of a younger generation, that Wallace independently developed his ideas respecting the theory of natural selection while travelling in the Malay Archipelago. It is, too, part of the romance of science that Darwin was profoundly ignorant of the fact that another mind in a distant region of the world was alike puzzling over the question of the origin of the classification and affinities of organic beings. In February, 1858—exactly fifty years ago—Wallace had written his conclusions in a paper entitled "On the Tendency of Varieties to depart indefinitely from the Original Type." This essay he sent to Darwin for his perusal and opinion thereupon. The subsequent course of events is best gathered from the subjoined copy of a letter sent by Sir Charles Lyell and Dr. (now Sir Joseph) Hooker to Mr. J. J. Bennett, then Secretary of the Linnean Society:—

London,
June 30, 1858.

MY DEAR SIR,

The accompanying papers, which we have the honour of communicating to the Linnean Society, and which all relate to the same subject, viz.: the Laws which affect the Production of Varieties, Races, and Species, contain the results of the investigations of two indefatigable naturalists, Mr. Charles Darwin and Mr. Alfred Wallace.

These gentlemen having, independently and unknown to one another, conceived the same very ingenious theory to account for the appearance and perpetuation of varieties and of specific forms on our planet, may both fairly claim the merit of being original thinkers in this important line of inquiry; but neither of them having published his views, though Mr. Darwin has for many years past been repeatedly urged by us to do so, and both authors having now unreservedly placed their papers in our hands, we think it would best promote the interests of science that a selection from them should be laid before the Linnean Society.

Taken in the order of their dates, they consist of:—

1.—Extracts from a MS. work on Species, by Mr. Darwin, which was sketched in 1839, and copied in 1844, when the copy was read by Dr. Hooker, and its contents afterwards communicated to Sir Charles Lyell. The first part is devoted to "The Variation of Organic Beings under Domestication and in their Natural State," and the second chapter of that Part, from which we propose to read to the Society the extracts referred to, is headed, "On the Variation of Organic Beings in a State of Nature; on the Natural Means of Selection; on the Comparison of Domestic Races and true Species."

2.—An abstract of a private letter addressed to Professor Asa Gray, of Boston, U.S., in October, 1857, by Mr. Darwin, in which he repeats his views, and which shews that these remained unaltered from 1839 to 1857.

3.—An essay by Mr. Wallace, entitled "On the Tendency of Varieties to depart indefinitely from the Original Type." This was written at Ternate, in February, 1858,

for the perusal of his friend and correspondent, Mr. Darwin, and sent to him with the expressed wish that it should be forwarded to Sir Charles Lyell, if Mr. Darwin thought it sufficiently novel and interesting. So highly did Mr. Darwin appreciate the value of the views therein set forth, that he proposed, in a letter to Sir Charles Lyell, to obtain Mr. Wallace's consent to allow the essay to be published as soon as possible. Of this step we highly approved, provided Mr. Darwin did not withhold from the public, as he was strongly inclined to do (in favour of Mr. Wallace), the memoir which he had himself written on the same subject, and which, as before stated, one of us had purused in 1844, and the contents of which we had both of us been privy to for many years. On representing this to Mr. Darwin, he gave us permission to make what use we thought proper of his memoir, etc.; and in adopting our present course, of presenting it to the Linnean Society, we have explained to him that we are not solely considering the relative claims to priority of himself and his friend, but the interests of science generally; for we feel it to be desirable that views founded on a wide deduction from facts, and matured by years of reflection, should constitute at once a goal from which others may start, and that, while the scientific world is waiting for the appearance of Mr. Darwin's complete work, some of the leading results of his labours, as well as those of his able correspondent, should together be laid before the public.

We have the honour to be,
Yours very obediently,
(Signed) { CHARLES LYELL.
JOS. D. HOOKER.

The two papers were duly read before the Linnean Society on July 1, 1858. Darwin tells us in his autobiography that they received scant attention. Professor Samuel Haughton, of Dublin (a mathematician, by the way), declared at the time that all that was new in them was false, and what was true was old. The seed of a great generalisation fell for the moment upon barren ground. For Darwin, however, the impetus given by Wallace's memoir was such that he set to work to reduce into orderly and condensed form the results of years of laborious study and observation of his own. The "Origin of Species" was published in November, 1859. Writing to Wallace in 1860, the brother naturalist says: "I admire the generous way in which you speak of my book. Most persons would, in your position, have felt some envy or jealousy. How nobly free you seem to be of this common failing of mankind. You would, if you had my leisure, have done the work just as well, perhaps better, than I have done it."

The first of a long series of scientific works that Dr. Wallace has produced during his strenuous career was the record of the journey that he and his friend Bates made to the Amazon Valley, in 1848. It appeared in 1853 under the title "A Narrative of Travels on the Amazon and Rio Negro." In 1869 there was issued the classic "Malay Archipelago, the Land of the Orang-Utan and the Bird of Paradise." This was followed by "Natural Selection and Tropical Nature" and "The Geographical Distribution of Animals" (two vols.). Subsequently there have appeared, "Island Life," "Darwinism," "Man's Place in the Universe," and "Australasia" (two vols.). The latest contribution in book form from his pen was published only the other day, entitled "Is Mars Habitable?" In addition to the foregoing, Dr. Wallace is responsible for a number of works on social life and conditions, containing much outspoken criticism.

T. E. J.

Artificial Diamonds.

Sir William Crookes's Experiments.

IT is within the knowledge of most people that, thanks to the methods indicated by the late Professor Moissan, the chemist is able to manufacture diamonds in his laboratory—minutely microscopic, it is true, but veritable diamonds with crystalline form and appearance, colour, hardness, and action on light identical with those attributes in the natural gem. Sir William Crookes, F.R.S., has shown the experimental method of manufacturing artificial diamonds, during the course

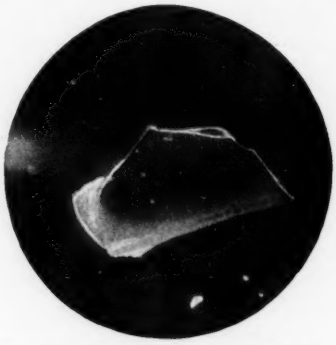


Fig. 1.—Artificial Diamond from Molten Iron.
(Thirty-two times natural size.)

of a lecture at the Royal Institution, and, thanks to his kindness, we are able to reproduce the substance of his remarks, together with some photographs of artificial diamonds.

Until recent years carbon was regarded as absolutely non-volatile and infusible, but the enormous temperatures of the electric furnace have proved that carbon obeys the same laws as other bodies. Carbon volatilises at ordinary pressure at 3,600 degrees Centigrade. It has been found that other bodies which volatilise

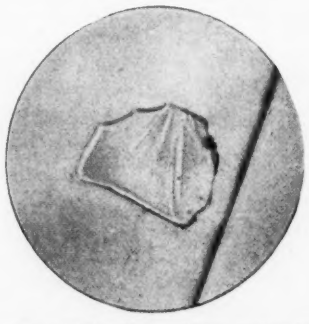


Fig. 2.—Artificial Diamond from Molten Iron.
(Thirty-two times natural size.)

without liquefying at the ordinary pressure will easily liquefy if pressure is added to temperature. It naturally follows that if, along with the requisite temperature, sufficient pressure is applied, liquefaction of carbon will take place and *on cooling it will crystallise.* But carbon at high temperatures is a most energetic chemical agent, and if it can get hold of oxygen from the atmosphere, or from any compound containing oxygen, it will oxidise and fly off in the form of carbonic acid. Heat and pressure are of no avail, therefore, unless the carbon can be kept inert. Iron is the substance for

the purpose. Iron melted dissolves carbon, and in cooling liberates it in the form of graphite. Moissan discovered that several other metals have similar properties, especially silver, but iron is the best solvent for carbon. The quantity of carbon entering into solution increases with the temperature, and on cooling in ordinary circumstances it is largely deposited as crystalline graphite.

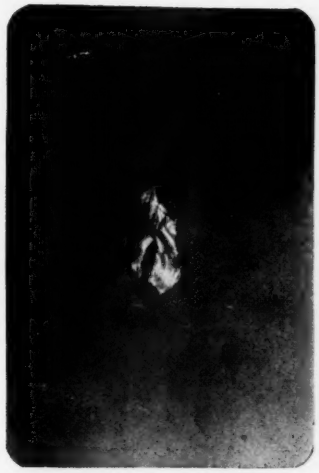


Fig. 3.—Diamond Crystal in the form of a drop (enlarged).

We now begin to see the conditions of the problem. We want a very high temperature, a very high pressure, and iron as a solvent. Sir James Dewar calculated some years ago what we may call the critical pressure of carbon; that is to say, the lowest pressure at which carbon can be got to assume the liquid state while at its critical temperature.

The intention is to get liquefaction at the highest possible temperature. The vaporising or boiling point of carbon is about 3,600 degrees Centigrade, or 3,874 degrees absolute temperature (absolute zero being 274 degrees below the melting point of ice). The "critical" point of a substance is, on the average, about one-and-a-half times its absolute boiling point. Therefore the "critical" point of carbon may be taken to be somewhere about 5,800 degrees absolute temperature.

But the absolute critical temperature of elements is always at least two-and-a-half times as great as the critical pressure. Hence we may deduce that the critical pressure of carbon is 2,320 atmospheres, or about 15 tons on the square inch. This is not a difficult pressure to obtain in a closed vessel, and as we can also get temperatures as high as 4,000 degrees we have both sufficient temperature and pressure to liquefy carbon and so produce the state in which it will, on cooling, crystallise. If the conditions could only be allowed to act for a sufficient time on the carbon there is little doubt that the artificial formation of diamonds would soon pass from the microscopic stage to a scale more likely to satisfy the requirements of science, industry, and personal decoration.

The first necessity is to select pure iron—free from sulphur, silicon, phosphorus, &c.—and to pack it in a carbon crucible with pure charcoal. Half a pound of this iron is then put into the body of the electric furnace, and a powerful arc formed close above it, between carbon poles, utilising a current of 700 ampères at a pressure of 40 volts. The iron melts rapidly and saturates itself with carbon. After a few minutes' heating to a temperature above 4,000 degrees Centigrade—a temperature at which the lime of the furnace melts like wax and volatilises in clouds—the current is stopped, and the dazzling, fiery crucible is plunged below the surface of cold water, where it is held till it sinks below a red heat. As is well known, iron increases in volume at the moment of passing from the liquid to the solid state. The sudden cooling solidifies the outer layer of iron and holds the inner molten mass in a tight grip. The expansion of the inner liquid on solidifying produces an enormous pressure, and under the stress of this pressure the dissolved carbon separates out in a transparent, dense, crystalline form—in fact, as diamond.

Now commences the tedious part of the process. The metallic ingot is attacked with hot nitro-hydrochloric acid until no more iron is dissolved. The bulky residue consists chiefly of graphite, together with translucent flakes of a chestnut-coloured carbon, black opaque carbon of a density of from 3.0 to 3.5, and hard as

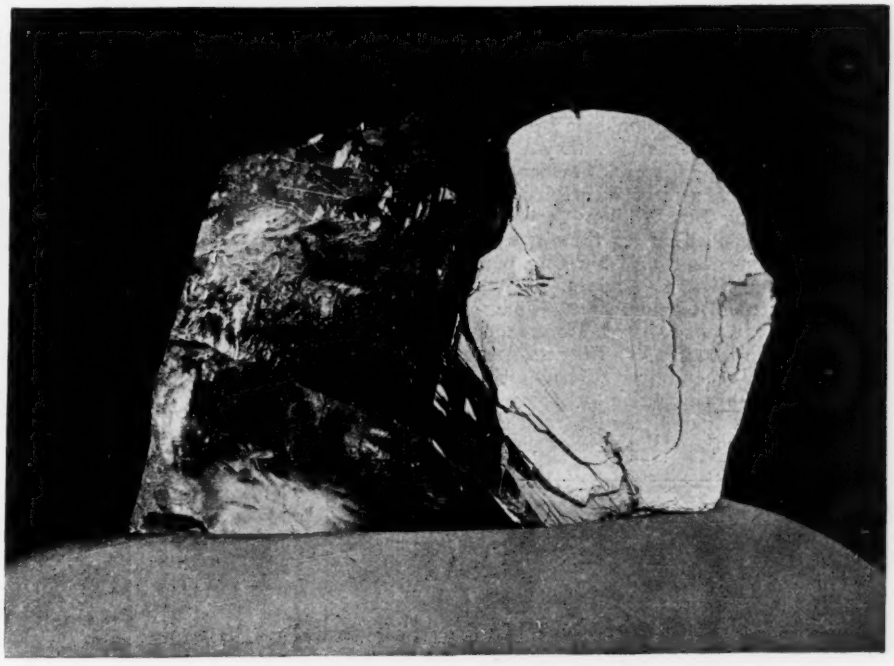


Fig. 4.—The Cullinan Diamond. Approximately natural size.

diamonds—black diamonds or carbonado, in fact—and a small portion of transparent colourless diamonds showing crystalline structure. Besides these, there may be carbide of silicon and corundum, arising from impurities in the materials employed.

The residue is first heated for some hours with strong sulphuric acid at the boiling point, with the cautious addition of powdered nitre. It is then well washed and allowed for two days to soak in strong hydrofluoric acid in the cold, then in boiling acid. After this treatment the soft graphite will disappear, and most if not all of the silicon compounds will be destroyed. Hot sulphuric acid is again applied to destroy the fluorides, and the residue, well washed, is repeatedly attacked with a mixture of the strongest nitric acid and powdered potassium chlorate, kept warm, but to avoid explosions not above 60 degrees Centigrade. This ceremony must be repeated six or eight times, when all the hard graphite will gradually be dissolved, and little else left but graphite oxide, diamond, and the harder carbonado and "bort." The residue is fused for an hour in fluorhydrate of fluoride of potassium, then boiled out in water, and again heated in sulphuric acid. The well washed grains which resist this energetic treatment are dried, carefully deposited on a slide, and examined under the microscope. Along with numerous pieces of black diamond are seen transparent colourless pieces, some amorphous, others with a crystalline appearance. Although many fragments of crystals occur, it is remarkable that one never sees a complete crystal. All appear broken up, as if on being liberated from the intense pressure under which they were formed they burst asunder. There is direct evidence of this phenomenon. A very fine piece of artificial diamond, carefully mounted by Sir William Crookes on a microscopic slide, exploded during the night and covered its slide with fragments. This bursting paroxysm is not unknown at the Kimberley mines.

The specimens of diamonds are all microscopic. Few artificial diamonds made by M. Moissan, or Sir William Crookes, or the late Sir W. Roberts Austen are more than the thirty-second part of an inch in diameter. For the purpose of comparison we append a photograph of the Cullinan diamond, the largest that has yet been found. It shows the actual size of the stone.

Two articles of considerable interest to the general reader, as well as of value to the scientific reader, appear in the current number of the *Strand Magazine*. One is on "Sensitive Plants," by Mr. J. J. Ward; and another, cleverly illustrated by coloured plates, is by Mr. A. E. Johnson on the "Physiognomies of the Animals at the Zoological Gardens."

Solar Disturbances During December, 1907.

As mentioned last month, the chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, and F. C. Dennett. The central meridian at noon on December 1 was 48° 45′.

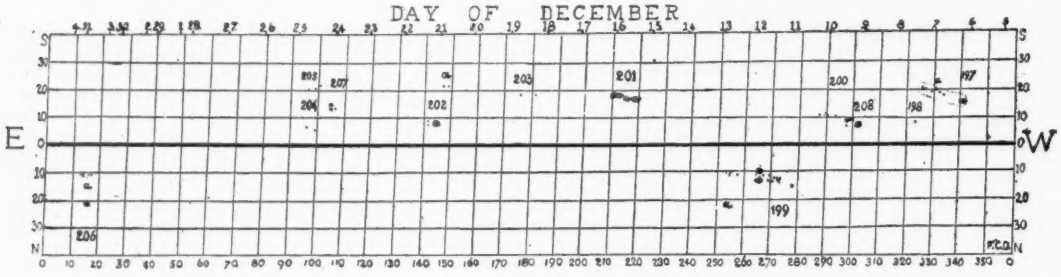
No. 197.—Repeated from last month's chart.

No. 197*a*.—An active group of spotlets, developed in the rear of No. 197, and joined to it by a great faculic disturbance seen 7th to 11th.

No. 198.—A pore closely *p*. the area of No. 183. 3rd to 7th.

No. 199.—The return of No. 187, showing considerable activity amongst its smaller members. Between 11th and 13th the bright bridge, crossing the umbra of the *s.f.* spot, changed its direction nearly 90°. 5th to 18th.

No. 199*a*.—In the rear of the last, the combined length of the two groups being 246,000 miles. 9th to 16th.



No. 200.—A group of pores, increasing when near the limb. 10th to 16th.

No. 201.—A naked eye group broke out on the disc, and was very active. The large spots 22,000 and 20,000 miles in diameter. 14th to 22nd.

No. 202.—A fine spot 24,000 miles in diameter, with pores behind it 17th to 20th, its umbra noted by McHarg as violet on 22nd. 15th to 27th.

No. 202*a*.—A pair of minute pores, hazy on 24th. 22nd to 26th.

No. 203.—Penumbraless pores, three 18th, pair 20th, one 21st and 22nd.

No. 204.—A pair of pores only seen 20th and 23rd.

No. 205.—Pores, three on 21st, two on 22nd.

No. 206.—A small spot 10,000 miles in diameter, dwindling, 25th to 30th.

No. 206*a*.—A group of six spores. 29th and 30th.

No. 207.—One black pore, with two hazy companions, in bright faculic setting, very near the area of No. 193, only seen 29th.

No. 208.—A spot 15,000 miles in diameter leading a group of pores of elliptical formation, 40,000 miles in length. On January 5 the area of the group was larger, being 67,000 miles long, but the members, though greater in numbers, had decreased in size. December 30 to January 5.

Ornithology and the Camera.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

THE introduction of dry-plate photography has had far-reaching consequences, and not the least important of these must be reckoned its application to the study of natural history, and of ornithology in particular.

If the "sportsman-naturalist" has done much to add to our knowledge of the ways of our native birds, the photographer has done more—infinitely more. And to amass this knowledge he has exhibited feats of endurance and patience, such as would appal "the man with the gun," whose aim is to kill; hunting his quarry from pillar to post, he gathers a store of information as to the ways and devices which birds adopt to avoid their arch-enemy, man. But on the whole, he gleans but little with regard to bird-life in this direction. His main object is to kill the victim marked down, perchance to have it stuffed. This done, save as a trophy, or an example of this or that British bird, all further interest in it is at an end. With a few exceptions he is a dull, unimaginative person, who has never got beyond the stage of "collecting."

It must not be supposed, however, that we desire to brand all who shoot birds for the cabinet as Philistines and mere "collectors." That would be stupid; but the number of those who make a scientific use of the birds they kill is unfortunately few.

Equally fallacious would it be to regard all who have achieved even a measure of success in the field of bird-photography as geniuses. On the contrary, as a study of the horde of books on the subject of bird-photography will show, a vast amount of rubbish has been put on the market by over zealous or undiscerning publishers.

But during the last few years some magnificent work has been achieved, and our knowledge of the everyday life of birds in a wild state has advanced by leaps and bounds. The work of the pioneers in this field, the Keartons, and Mr. R. B. Lodge, is too well-known to need special notice here. A year or two ago they met with a serious rival in Mr. Boraston, who combined the pen of a ready writer with the technical skill of the photographer.

From "The Home Life of Some Marsh Birds."]

The Great Crested Grebe.

But even his work has been eclipsed by the later work of Miss E. L. Turner and Mr. Philip Bahr, at any rate, in so far as variety is concerned.

Miss Turner's best work has been done on the Norfolk Broads, and especially on Hickling Broad, where she has not only secured some very remarkable pictures of nesting grebes, coots, bearded-tits, and other birds, but has also added many new facts as to the habits of these birds, which are of extreme interest and value. Mr. Bahr has ranged further afield, but his contributions to ornithological science are no less valuable.

As an example of what may be done with a camera,

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and a model of the way in which birds in their natural haunts should be studied, we venture to think the little brochure by Miss Turner and Mr. Bahr (Witherby and Co.) will be regarded as one of the best that has yet appeared.

Miss Turner contributes four delightful essays, choosing as her subjects, "Great Crested Grebes and Coots," "The Water-rail," "Bearded Tits," and 'Three Marsh-land Warblers," and each is a gem. For while each of her themes is full of new facts, she writes with a quiet humour, and expresses what she has to say with a rare delicacy.

Among other things, she tells a very good story of a coot, which had, curiously enough, built her nest within a few feet of that of a great crested grebe. Of these neighbours she writes: "A very amusing incident occurred one day. During the grebe's absence, the coot was seized with feminine curiosity, and a desire to pry into her neighbour's *ménage*. After casting one or two guilty looks behind her, she crept up to the grebe's nest, and, removing the covering from the eggs, proceeded to move them about, giving one a specially vicious poke as she did so, which may account for only two out of the three hatching out. As she was moving her head from side to side, as if contemplating further mischief, I thought it best to release the shutter of my camera, whereupon she fled in alarm; but not before I had secured damning evidence against her, and by the time she was decently composed upon her nest her neighbour returned."

Of the bearded-tit, one of the most precious of our native birds, Miss Turner has much that is interesting, and much that is new to say. And speaking of the persecution to which these birds are subjected, because of their rarity, she feelingly remarks: "If only a greedy 'private collector' could now and again be shot, what an immense boon would be conferred on ornithology in general." In this we most heartily concur.

Mr. Bahr's contributions are every whit as delightful as those of Miss Turner. He has chosen as his subjects, "The Snipe," "The Red-Throated Diver," and "A Nesting Colony of Black-Headed Gulls," and he has supplemented some really superb photographs with a number of most spirited pen and ink sketches. His photographs, like those of Miss Turner, are more than charming pictures, they possess real scientific merit. For example, he has caught, in one of these pictures, the red-throated diver in the act of walking, a feat which this bird has been commonly believed incapable of performing. Among his pen and ink studies, special mention should be made of those illustrating the changes of plumage of the young black-headed gull, and the curious antics of the red-throated diver.

Each of his three chapters contains facts that appear to us to be new, and some of these are of peculiar interest. His comments, for example, on the high rate of mortality in the breeding colonies of black-headed gulls, and the causes thereof, are well worth study, affording as they do a curious insight into the conditions of existence as they obtain among species which elect to breed in large communities.

In short, this is a really wonderful little book, and how the publishers have contrived to issue such a volume so profusely and beautifully illustrated for the small sum of half-a-crown, puzzles us. Even the announcement that it is a "special photographic number of *British Birds*," the new monthly magazine of ornithology, does not lessen the mystery.

Porpoises at the Bow of the "Ophir."

By WILLIAM J. S. LOCKYER.

IN a recent number of this journal (January, 1908) Mr. C. H. Gale contributed a short illustrated note concerning porpoises playing about in front of the bow of a moving steamer.

It may not be without interest to refer here to another photograph of a similar nature, since it is quite probable that such photographs are very few and far between.

In January of 1893 I was returning to the University of Göttingen (North Germany) from London, and by

Porpoises playing about the bow of the R.M.S. "Ophir" off Cape Trafalgar, January 4, 1893, 10 a.m.

fortunate circumstances I was proceeding thence by rather a circuitous route. The sea portion of the journey was made by travelling from Tilbury to Naples in the R.M.S. "Ophir," while the land portion was accomplished by train *viâ* Rome and the St. Gothard Pass.

Most delightful weather was experienced in passing through the Bay of Biscay, and also in steaming along the coast of Portugal. Off Cape Trafalgar, the scene of the memorable sea-fight, the sea was as smooth as a mill pond, and the water exceedingly clear. About the bow of the "Ophir" porpoises were playing in considerable numbers; the ship speeding through the water and the brilliant sunshine seemed to invite them to frolic both in the air and water.

The astonishing part of the occurrence was that although the "Ophir" was proceeding at a fair pace,

her velocity might have been discounted altogether so far as it inconvenienced the porpoises, for they played about the bow in a manner as easily as flies about the head of a quickly-moving horse.

Each porpoise in turn seemed to enjoy the sport of jumping out of the water, and so closely did they sometimes cross in front of the steel bow of the "Ophir" that one wondered that they were not struck by it.

The accompanying illustration, from the untouched original negative, was taken with a 5 by 4 Eastman Kodak, the camera being pointed nearly vertically downwards from the forecastle head. Six porpoises can be easily seen, four of which were several feet below the surface of the sea, while two were in the act of jumping, and made a considerable splash as indicated in the illustration. The bow of the "Ophir" is seen cutting its way through the water.

Field Botany.—An experiment in field botany, which has been in progress some three or four years, is reviewed by its director, Professor F. W. Oliver, F.R.S., in the Transactions of the South-Eastern Union of Scientific Societies. The experiment took the form of selecting an area of salt-marsh at Erquy, in Brittany, for observation over a term of years, and of noting on this area, for example, the distribution of zones of vegetation; the physical characters of the soil, its salinity, and the plants appropriate to such conditions; the migration of the plants; why some spots are always bare; and so on. It is impossible in the space of a note to summarise all the points of scientific inquiry extending over a quadruple investigation. Suffice it to say that the investigations have been conducted by a party of from twenty to twenty-five students, past and present, of University College, reinforced by specialists drawn from outside, with about ten students new to the work in each succeeding year. Brittany, we may surmise, was chosen partly because of its cheapness, and partly because a party of students similarly engaged in England is apt to be regarded as a species of poachers by the aborigines. The experiment, apart from its scientific value, is interesting as affording an example of the new spirit pervading scientific research. In science the day of the isolated worker is passing away; and in its place is springing up an impulse not unlike that which in mediæval times joined architects, sculptors, painters, and all sorts of skilled artificers to erect and beautify some noble building, to which each brought the best of which he was capable. The idea of this common undertaking, by which the most enduring monuments can be raised, has yet to permeate more fully the unit organisations; but this will be accomplished with the lapse of time.

Musical Sands.—Some "singing sands" from New South Wales were exhibited before the Physical Society by Mr. S. Skinner. The peculiarity of these sands is that when dried and placed in a jar the sudden pressure in their midst of a pestle or other blunt instrument produced what may be described as a musical note, though it is a note of a discordant kind, and very like a squeak. The difficulty of explaining the true cause of this musical note has led to a correspondence in *Nature*, and no quite satisfactory answer to the question has yet been furnished. The chief peculiarities of the sands appear to be the hardness of their angular grains and their freedom from very small grains. It has been suggested that the absence of very small grains may be the predisposing cause. But it is not easy always to distinguish the presence of very small grains, and a curious instance of this disability was suggested to the writer of these notes. Why is it that a china cup will usually slip on its saucer, whereas the presence of liquid in the saucer prevents the slipping? The unexpected answer is that when a cup slides or slips on a saucer it is sliding on the microscopic grains of glaze which friction produces. These grains are quite imperceptible, but there is reason to believe that they serve as a kind of roller bearings. When liquid is in the saucer their formation is prevented and the cup does not slip.

The Stereoscope and the Dimensions of Space.

By G. H. BRYAN, F.R.S.

THERE are undoubtedly a great many people who derive pleasure and enjoyment from the contemplation of speculative questions regarding the "dimensions of space." A study of this kind, if it is to furnish any *real* contributions to our knowledge, must be essentially of a mathematical character, and should not stop at four dimensions, but should be capable of extension to five, six, or generally n dimensions. The mere question "What is the fourth dimension?" hardly comes within this category. The subject of the present note was suggested by Mr. Benham's article on the stereoscopic twin elliptical pendulum curves, and involves an extension of ideas contained in a previous paper on "The Double Stereoscopic Projection of the Eight Cell." It is addressed to the class of reader mentioned above, rather than to mathematicians, although there is nothing in the suggestions that could be regarded as *incorrect*.

In the first place it is possible by means of an extension of the principle of the stereoscope to form a conception of figures in *four* dimensional space, represented by diagrams drawn on paper.

When we use two eyes to look at objects in the three dimensional space in which we live, we really see two slightly different pictures, and we are accustomed, as the result of experience, to associate the differences with differences of distance from our eyes.

If A and B are two points of which B is the further off, then in the picture seen by our left eye, the position of B relative to A is a little further to the left than it is in the picture seen by our right eye, and *vice versâ*. When we try to represent these differences in a pair of drawings for use with the stereoscope, the net result is that the representations of a distant point in the two pictures must be a little further apart than those of a near point. When one picture has been drawn the points in this picture must be slightly displaced in a horizontal direction in order to obtain the second picture, the amount of this displacement depending on the distance which it is desired to represent. But it is necessary that the two representations of the same point should be on the same horizontal level.

Now, it is easy enough to draw a pair of diagrams in which the latter restriction is removed. A point might be represented a little *higher up* or a little *lower down* in the left-hand picture than in the right, and this might be done in a different way for different points. These differences are closely analogous to those which enable us to represent distance in the stereoscope, but being in a vertical instead of a horizontal direction they cannot be associated with any conception of *distance* of which we have experience.

If, now, we say, "Let these differences be regarded as representing differences of position associated with a fourth dimension in space," we are, of course, making a purely conventional hypothesis. There does not, however, appear to be any *primâ facie* reasons for dismissing such an assumption as being obviously absurd or fantastic. The differences certainly cannot be regarded as representing the notions of nearness or farness. If we ask ourselves the question, "Which is the nearest and which is the furthest off, a point which is represented higher in the left-hand picture than in the right, or a point which is represented higher in the right-hand picture than in the left?" the safest answer, and the one which will not land us in future difficulties,

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is that the one interpretation is neither better nor worse than the other. This is exactly the answer we want, for differences of position in a fourth dimension of space must necessarily be independent of any notions of *distance* of which we can have experience. Or, again, we may say this: If we assume a system of rectangular axes in space of any dimensions whatever, the choice of which directions along these axes shall be regarded as positive, and which shall be regarded as negative is purely a matter of convention. Points which are shown on the same level in both pictures clearly belong to the space in which we live, and their "fourth dimension" is, therefore, correctly represented as zero.

If any person should wish to make the attempt to actually *see* four dimensions with a stereoscope, he would require the exercise of a considerable amount of imaginative power and a great deal of practice in interpreting diagrams in accordance with the assumed hypothesis. The attempt could be rendered easier by having diagrams drawn on circular discs which could be rotated simultaneously about the centres of the fields of view of the two halves of the stereoscope. After they had turned through a right angle, the vertical displacements would become horizontal, and *vice versâ*; thus the "fourth dimension" distance would become interchanged with the "third dimension" distance or actual visible and tangible distance measured perpendicular to the plane of the diagram. Whether the attempt is worth making must be left to the judgment of every reader for himself; at any rate, the first attempts would not be likely to result in success.

The stereoscopic pendulum curves of Mr. Benham's paper are, strictly speaking, representations of four dimensional curves, but they usually look like ordinary curves standing out in relief in three dimensional space; the differences of level of the tops and bottoms of the loops being either unnoticed or regarded by the eye as mere inaccuracies of the figures. In fact, figures made up of *lines* lend themselves badly to this mode of representation. The eyes naturally associate those points with each other which are on the same level in both figures, and it is only at the tops and bottoms of the loops that this interpretation fails. In diagrams made up of lines, the points of intersection of which are not at the same level, the eyes would more naturally give the interpretation that the lines did not intersect.

Admitting, however, the above convention, we could go a little further by replacing the two stereoscopic diagrams by two solid models.

Let one model be constructed and let a second model be derived from the first by slightly displacing its various points in different ways. We may treat each displacement as made up of three displacements measured in three different rectangular directions. If each of these displacements be regarded as representing some kind of *distance*, we obtain a representation of a figure in space of *six* dimensions; but the possibility of actually *seeing* six dimensions by this method had better be dismissed.

I must again warn my readers not to attach any undue significance to the suggestions contained in this note. If anyone wishes to *think* of space of more than three dimensions, the suggestions may indicate one way of doing so. But there is so much to be done in mathematical research in reference to tangible and practical applications, and there are so few people who have the necessary training to study problems which are under our very eyes, that these attempts to explore the unknown should not be entered on except for any mental pleasure they promise to give to those embarking on such a study.

The Recent Total Solar Eclipse.

By WILLIAM J. S. LOCKYER.

IT is very satisfactory to be able to record the fact that successful observations have been made by the parties which went out to observe the eclipse of January 3 last. The observing station chosen was on Flint Island, in the South Pacific, a coral island of very small dimensions, but well situated near the line of central totality. One of the parties in question was an official expedition from the Lick Observatory in America, and it was under the direction of Professor W. W. Campbell, and was accompanied by a man-of-war, the "Annapolis." The second party, the only British one present, was one organised and directed by the zeal of Mr. F. K. McClean, of Rusthill, Tunbridge Wells.

Up to the time of writing the news received is, necessarily, rather scanty, since the nearest cable station was Auckland, New Zealand, and that had to be reached. It is, however, now known that the morning of eclipse day broke very fine, but for some minutes up to the time of totality heavy rain is reported to have fallen.

The first minute of totality was, unfortunately, lost, owing to the clouds covering the eclipsed sun, but for the remaining three minutes the sky cleared and these precious moments were successfully utilised, both parties having apparently made the most of them.

Whether Professor Campbell developed any of his plates previous to the sending off of the cable is not at present known, but his expedition is reported to have been a success. Mr. McClean made use of the room which he had had converted into a dark-room on the steamer he had specially chartered, and he has reported that four of his corona pictures are considered satisfactory.

It was expected that the corona would take the "square" form, a shape generally assumed when the eclipse occurs between the epochs of greatest and least solar activity. As it is reported that the corona resembled that of the year 1898, the expectation is realised. Further details of the observations will, however, be awaited with interest.

It would be unfitting to bring this brief note to a close without congratulating Mr. McClean on the energy and enterprise he has displayed not only in organising, in so complete a manner and at a large personal cost, his expedition, but in obtaining results which will no doubt prove of great value.

Proliferation in Ferns.—Ferns are perhaps more apt to form "sports" than any other members of the vegetable kingdom, nevertheless, records of such sports produced by specific kinds, and from stated localities, are always of value. The following note, bearing on this subject, has been communicated by Mr. James H. Worthington, Budon, Wellington, Somerset:—"Both here and in Devon I have on various occasions found plants of the harts-tongue fern whose fronds were forked, sometimes to an extraordinary extent. It is commonest to find specimens of this sport with two points, very short, and at the tip of the frond, but sometimes I have found them with as many as eighteen points, and in such cases the forking usually takes place near the base of the frond, and these forks are again forked, often ending in a bunch of three or four tiny points. I have before me as I write several specimens, with two and three points. I have noticed that the shield fern has often similar sports, producing a bunch of tiny fronds on the tip of the ordinary one. The spores are present, in the case of the harts-tongue, on normal and abnormal fronds alike. I have also noticed that when abnormal fronds are produced, all fronds from the same plant are to some extent abnormal."

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

New Yellow Screens.

The ordinary yellow glass is more correctly described as brown, for it absorbs quite a notable amount of green and red light, and the most that can be said in its favour is that it absorbs a still larger proportion of violet and blue. As the screen is used to compensate for the deficient sensitiveness of plates to green and red, any absorption of these colours is a great disadvantage, for it not only needs an increase of exposure on its own account, but, as it neutralizes a part of the effect of the reduction of the blue light, for a given amount of correction it is necessary to increase the depth of colour beyond what would otherwise be required, and therefore the duration of the exposure has to be still further increased. By the use of suitable dyes, it is possible to prepare films practically free from this defect, and a screen so made that necessitates a double exposure may give the same amount of correction as a glass screen that requires four or more times the exposure suitable when no screen is used. The Jena glass works, that has done and continues to do more than any other factory to provide glass suitable for optical needs, has been successful in making a yellow glass so vastly superior to what we have been accustomed to, that screens made of it are comparable to those prepared with dyes. Glass coloured homogeneously in the making has obvious advantages over a stained gelatine or collodion film. It will not be so easily injured by rough usage, and presumably the colour will be more stable. The new screens are issued by Messrs. Staley and Co., of 19, Thavies Inn, E.C., in two depths of colour, requiring approximately twice and four times the exposure with no screen, the darker tint giving a correction equal to or exceeding that given by the darkest of the ordinary glass screens in common use.

The Effect of Coloured Screens on Exposure.

Obviously, as the function of a coloured screen is to absorb a part of the light that the plate is unduly sensitive to, so far as it has any effect it must lead to the necessity for an exposure of increased duration. How much the exposure must be increased is always a difficulty, and it is only a few months ago that the question was raised and very variously answered, as to the effect on the necessary exposure of doubling the screen colour, or using two similar screens. The fact is, that all expressions as to the proportion of increase in the exposure are at the best vague and only approximate, for the increase depends on the screen, the plate, and the subject. Suppose, for example, that the subject gives only pure green and red light, and the screen absorbs only the blue and violet, the exposure will be the same with or without the screen, or even with several screens. If the plate has a large preponderance of sensitiveness to blue, and the screen is so light in tint that it leaves a large excess of blue effect on the plate, then if one screen requires a doubled exposure, two will require four times, three, eight times, and so on, until the large preponderance of blue effect has been so reduced that the sensitiveness of the plate to green or red becomes notable when compared with the effect produced by the blue. Then as the green and red are not absorbed, increasing the depth of tint of the screen will produce less and less effect in increasing the required exposure. All multiplying factors stated with regard to screens are, therefore, at the best, only rough guides in ordinary work. The same may be said of plate sensitiveness numbers by whatever system they are evolved. With a yellow screen, the uncertainty of exposure is increased, and it is only the comparatively large margin of suitable exposure that makes ordinary photography possible. Nothing but experiment will give the value of a screen or of a combination of screens. I have been told authoritatively of a certain screen that it needed an increased exposure of six or eight times, when experiment showed that it was really about twice, and this twice proved quite satisfactory for a considerable series of ordinary views.

Diaphragm Shutters.

In the most desirable form of these shutters the opening and closing are rapid, and the duration of the exposure is determined by a brake that keeps the closing mechanism out of action for the necessary period. The opening and closing are effected by springs, and the actuating mechanism merely allows these to act by releasing them. When the brake is out of action the closing follows immediately on the opening and this represents the quickest exposure; but it does a great deal more, for it is an indication of the efficiency of all the other exposure periods. In the consideration of such shutters it is not merely a question as to whether the photographer needs a range of exposures from one second to the one-hundredth of a second, or from one second to, say, the two-hundredth of a second. A shutter that gives the shorter of these two shortest exposures will give a greater efficiency through its whole range of exposures. This increased efficiency will be quite negligible in case of the one-second or the half-second exposure, because in these cases it will make no practical difference whether the opening and closing are done in the one- or the two-hundredth part of a second, but it will make a notable difference in the shorter exposures. The hundredth of a second exposure with the quicker moving shutter will give fifty per cent. more light through its opening than the other will for the same time. On the other hand, the quicker the movement, other things being equal, the shorter the life of the mechanism. But within reasonable limits this is an item of very little importance if the apparatus is suitably constructed, because the most used shutter is working for an infinitesimally short time as compared with clocks and watches that are always on the go. Therefore, with such shutters the increase in rapidity indicates progress in the right direction, even when only moderately short exposures are desired.

I have been led to make these remarks by an examination of one of the new series of "compound" diaphragm shutters issued by Messrs. Staley and Co. While moderate in price, these shutters give exposures of from one second to the one-hundredth of a second which are accurate within the practically negligible error of about ten per cent. But the quickest exposure is shorter still, about the half of that marked the one-hundredth, and the makers state that they hope to be able to get it still shorter. These shutters are light, very neatly made, and the mechanism is enclosed so that it may be kept as free as possible from dust. The pneumatic brake is within the case. There is a setting lever distinct from the release, an arrangement that is doubtless advantageous when strong springs are employed.

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The Rings of Saturn.

By W. W. BRYANT, F.R.A.S.

SINCE the time when Galileo exclaimed: "Has Saturn, then, in very deed devoured his children?" in allusion to the ancient myth, his crude telescope for the first time failing to reveal the strange appendages of the planet, the phenomena and constitution of the "rings" have provided a most interesting subject for observation and discussion. Huyghens was the first to discover that the general form was that of a flat ring surrounding Saturn in the plane of its equator, and Cassini is generally credited with the discovery of the first great division indicating the plurality of the rings, but it was long after their day before anyone seriously questioned the solidity of the system, which suggested to Laplace the germ of his Nebular Hypothesis. When

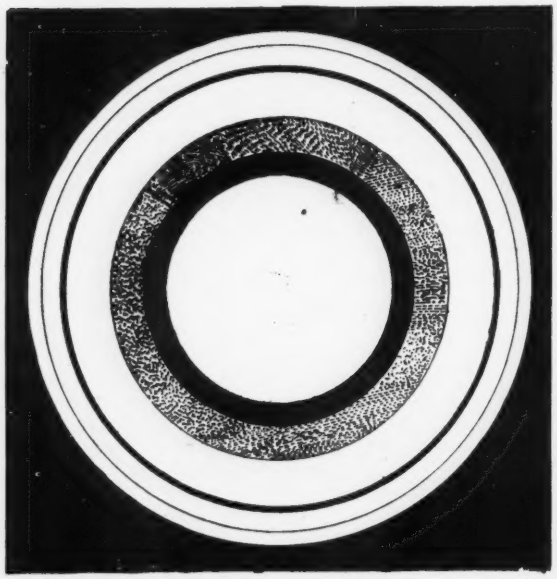

Fig. 1.—Saturn's Ring System viewed from above. Dimensions from measures uncorrected for irradiation. Showing outer ring with Encke Division, Cassini Division, inner bright ring, crape ring, disc of planet, with space surrounding it.

once assailed, however, by Laplace, the idea of a solid form for the ring system crumbled steadily away. If solid, the outer portion must be moving quicker than the inner, introducing strains and stresses too great to be borne by the fabric, so Laplace suggested a series of concentric rings to evade the difficulty. Moreover, Roche, of Montpellier, sixty years ago showed that the ring approaches the planet nearer than the limit within which tidal forces would disrupt a satellite. So that when Clerk Maxwell attacked the problem in his Adams Prize Essay in 1857, his result, that the only possible case of stability was an aggregation of fine particles, not only set the seal of mathematical demonstration on an old suggestion as to non-solidity made by Thomas Wright, of Durham, among others, but also went further than G. P. Bond and Peirce in excluding the possibility of a stable fluid form.

The fine division in the outer ring bears the name of Encke, and many evanescent and probably incomplete divisions have been noted from time to time by other observers, in addition to the so-called "crape" ring of Bond stretching towards the planet from the innermost edge of the bright ring.

In 1851 Otto Struve concluded from a comparison of measures of the dimensions of the ring dating back to the original measures of Huyghens, that the rings were closing in on Saturn at a rate of several miles per annum, and the table of measures given by him showed this in a very marked way. But although the result of collisions between the small bodies composing the rings would undoubtedly have a tendency to close in the orbits on the whole by reason of the loss of "vis viva" due to imperfect elasticity, which would cause some of the energy to be transformed into heat, yet Otto Struve's figures were startlingly large. It was with a sense of relief, therefore, that his repetition of his measures in 1882, after a complete revolution of Saturn, showed a change not exceeding one-tenth of his predicted value. A careful and critical survey of

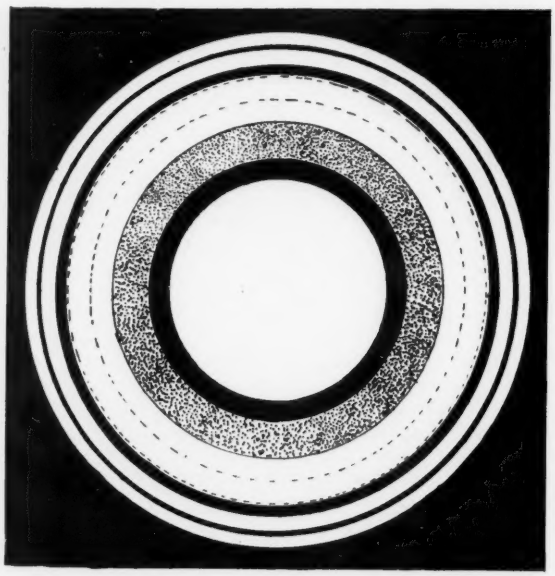

Fig. 2.—Saturn's Ring System viewed from above, with Dr. See's corrections (modified) for irradiation. The dotted circles indicate the position of Professor Lowell's outer "tore"; the inner one being practically coincident with the crape ring.

his data, combined with more recent measures, was published by Lewis in "The Observatory" for 1895*, showing beyond all reasonable doubt that Otto Struve had treated the old observations in an unjustifiable manner, and that really the change shown was too small to be certain, and was much less than the range between different observations; this range being largely due to the instrument used.

Lewis at the same time lamented the lack of observations of the dimensions of the system, a lack which is still by no means too well supplied.

At about the same time the late J. E. Keeler, by a very delicate spectroscopic observation, obtained direct confirmation of the fact that the outer part of the ring was moving more slowly than the inner, a fact already inferred from the theory of discrete particles forming the ring, in connection with Kepler's Third Law.

In 1900 and 1901 Dr. T. J. J. See published† the results of numerous measures taken by him or under

* Vol XVIII., pp. 379 385.

† *Astr. Nachr.*, Nos. 3,686 and 3,768.

his direction with the great equatorial of the U.S. Naval Observatory at Washington, D.C. The second set was ostensibly corrected for irradiation, which had been a great stumbling block to Otto Struve in the correct interpretation of old observations.

But, unfortunately, the results cannot be accepted as they stand, on account of errors made principally in correcting (?) for irradiation.

Last November much attention was directed to Saturn's rings, which were then due to pass through the phase which so disconcerted Galileo, when the plane of the ring passed practically through the earth, as it is bound to do twice in every complete revolution, *i.e.*, once in about fifteen years.

Once more the fact emphasised by Lewis came into prominence, viz., that the appearance is, to a very great extent, dependent on the power of the instrument. Some observers asserted that they watched the actual "disappearance" of the ring as the earth passed through the plane, and noted the reappearance on the other side. Others, again, maintained that they could see the ring all the time, or that it disappeared at a different date. Professor Lowell, of Flagstaff, Arizona, has published a drawing of the ring as seen edgewise, showing a thin line of dark shadow across Saturn with accompanying wings of fainter shading, of considerably wider extent. He himself, in an article in the *Scientific American* (December 14, 1907, p. 441-2), claims that this is new and is not to be explained by simple shadow or penumbra, but that the black line is probably the shadow of the outer ring only, and the fainter shadows represent the effect of light interrupted by bulging portions of the inner ring outside the plane. In addition to this he gives measures of apparent bright points on the ring beyond the disc on both sides, which he explains similarly as the same bulging portions seen in a more favourable position (just as the tail of a comet, really in the shape of a hollow cone, appears as two bright lines shading off to almost darkness between).

I have seen very similar drawings before both as to the shading and as to the "beads" on the thin line of ring visible, and there does not appear to be anything very novel in the explanation suggested, which is probably quite satisfactory. It has been suggested by Olbers and others, on the assumption that the rings were an absolute plane, that the bright points are the places where the greatest thickness of actual ring is seen, but I do not remember seeing any previous measures to prove this, and it does not seem so plausible as that given in Lowell's article, which is not very different to that of Proctor. It is certain that the further explanation given in the article as to the cause of the "bulging," and, incidentally, also of the divisions of the ring, is nothing more nor less than Kirkwood's Law, given by a very distinguished American astronomer who died several years ago. The Cassini division is connected by this law with at least four of Saturn's satellites, whose periods being commensurable with that of particles at the mean distance of that division, have caused their attraction to prevent the sojourn of particles at that distance, compelling an excess of collisions just within that limit and, consequently, an excess of particles pushed above or below the general plane. Hence what Americans call a "tore" near that distance, the section being more like that of a flat "quoit" than that of a "washer," except that the thickness diminishes in exactly the opposite way to that of a quoit, and may not be so regular.

Lowell gives measures of the distance of the bright points which agree perfectly with this explanation as regards the outer pair. His inner and broader pair, attributed to two critical distances not widely differing, corresponds on the whole to the inner edge of the crape ring, where the extra frequency of collisions required may also be plausibly referred to the fact that there is less and less room within the ring. It would almost seem as if the whole of the crape ring resulted from collisions in the inner bright ring, the particles nearer Saturn to begin with being driven in increasing numbers within the inner edge of the bright ring. It seems certain that the crape ring only differs from the others in density. Under favourable conditions, when the earth and the sun are only a few degrees above the plane, it has been noted as quite bright. Lowell seems to think the crape ring is visibly nearer the planet than it was. But, as I have said before, a great deal must be allowed for the instrument and the "seeing." It is no more fair to infer that the crape ring is a few thousand miles nearer than it was in Bond's time, than it would be to say that the same ring did not exist before Bond saw it.

To determine a question like this, comparison must be made at as long an interval as possible between measures under as nearly as possible identical conditions, with the same instrument, equally good "seeing," and, if possible, the same observer.

Now that Saturn is rapidly becoming year by year more favourably situated for observation in the northern hemisphere, it is to be hoped that series of measures will be undertaken at more observatories to test whether the theoretical shrinkage of the inner edge of the ring can be proved to take place at a measurable rate. And if the measures are made, they should be published in full detail, measured, not in "radii of Saturn," but in seconds of arc, so that they may be more comparable *inter se*: otherwise irradiation may again vitiate the results.

The American "Pipe Line."—In England, the "pipe line," which has given rise to a household phrase in America, is unknown, and it is necessary to explain that its use is to convey crude oil from the tanks to its destination sometimes hundreds of miles away. An invention of a peculiar kind has been devised to convey the crude oil from Oil City to Porta Costa, California, a distance of 285 miles, and it takes the form of a "rifled" pipe. The crude oil to be handled is a very viscous fluid with an asphalt base, and attempts to convey it by long pipe lines of the ordinary type failed because of the high pumping pressures required, and the very expensive pipes. Various expedients were tried, including the heating of the oil. This facilitated the conveying of the oil for short distances, but a temperature sufficient to be effective for long distances was so great as to cause the disintegration of the oil. The introduction of water into the oil was tried, but the proportion of water required was so high and the resulting emulsion of oil and water was so difficult and expensive to separate that the scheme proved a failure. The admixture of light oils with the heavy oils was more successful, but this also was too expensive. Finally, a rifled pipe was suggested. A small quantity of water is conveyed into the pipes at the pumping station, and the effect of the rifling is to produce a whirling motion of the liquid mass, which causes the water to be thrown toward the outside, thus forming a film of water enveloping the oil and greatly reducing the frictional resistance against its flow. The process is thus one of lubrication of the oil core. The pipe finally adopted is an 8-inch steel tube, tested to a pressure of 1,200 pounds to the square inch, and rifled by rolling, so that one complete turn is made in each 10 feet length. There are pumping stations every twelve and a half miles, each with its discharging tanks, and therefore twenty-three in the 285-mile line.

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CORRESPONDENCE.

Is There a Central Sun?

To the Editors of "KNOWLEDGE AND SCIENTIFIC NEWS."

SIRS,—I assure Mr. Henkel that I have the greatest admiration for the late Richard Proctor's wonderful work; but since he made his statements about the difficulty of getting an accurate estimate of the sun's velocity, some progress has been made. I take, as my authority, Sir David Gill, who, in his admirable presidential address at the British Association, last August, said: "It now seems almost certain that the true value of the sun's velocity lies between 18 and 20 kilometres per second." If I took Struve's figure, which is a little higher, it was simply as a courtesy towards Mr. Henkel himself, who gave it in his interesting article published in your July number. By the way, I never suggested in mine that he considered Alcyone or the Pleiadic group to be the centre round which our sun revolves, because I understood very well that he did not do so. I specially referred to many Continental astronomers who supported such a view, and I think Mr. Henkel is not a Continental scientist.

Now, my way of calculating the mass of the central body, *should* there be one, is not a stretch of imagination, as Mr. Henkel suggests, but a result of the application of the figures to the universal formula $\frac{V^2d}{M}$ = constant, deducted from the harmonical Keplerian law, taking the masses into account—a formula which applies not only to the planets revolving round our sun, but also to any moon revolving round its planet, to any star revolving round another one, and very likely, I think, to any electron revolving round an ion. Mr. Henkel, or any reader of "KNOWLEDGE," may verify the accuracy of the formula. They may do it by multiplying the square of the velocity of our moon by its distance to the earth, and dividing by the mass of the earth; then multiplying the square of the velocity of Phobos by its distance to Mars and dividing the result by the mass of Mars; then, again, multiplying the square of the velocity of Neptune (or of any other planet) by its distance to our central body, and dividing by the mass of the sun, and so on. They will always find the same result.

To be quite accurate, we ought to take, as the mass, that of the central body *plus* that of the revolving one, and as the distance, that of the revolving one to the centre of gravity of the system. But in many cases when the distances are enormous, and consequently the masses of the central bodies must be considerably greater than those of the revolving ones, we may take the data as we have already done, without finding much difference in the result. Let us say the same about Struve's estimate. If we take the accurate one suggested by Sir D. Gill, we should find, of course, different results; but not such as might affect the strength of our demonstration. So, with all the respect due to Mr. Henkel, I hold that we ought to dismiss, once and for all, the idea of our system revolving round a central sun.

Moreover, I should advise Mr. Henkel to apply the above Keplerian formula to one of the exterior stars of the Pleiades as supposed revolving round Alcyone with an average starry velocity, and he will find that the mass of Alcyone ought to be, in this case, hundreds of times greater than that which he himself attributes to that interesting star. Perhaps, then, he would not feel so inclined to believe that Alcyone is *a* central sun, and that the Pleiades, taken as a whole, constitute a physical group.

Yours, etc.,

F. T. del MARMOL.

London, N.E.

[All estimates of the velocity of the solar motion depend upon the average distances of the stars from our system, and even the best determinations vary greatly. Certain *angular* displacements, known as "proper motions," are known to be partly due to the solar motion, but it is evident that the linear motion in miles corresponding to a given angular motion (in seconds of arc) must depend upon the actual distance of the moving bodies. In travelling by train we notice the rapid displacement of neighbouring objects, whilst the Sun or Moon, being very distant, for instance, appear unchanged in position. In only a few cases have even approximate values been obtained for the distances of the nearest stars. Sirius, according to Gylden, is distant about 100 billions of miles from us (10^{14}), according to Gill and Elkin, about 50 billions of miles (only one-half, 61 Cygni, propably the best determined of all, lies, according to Hall, about 80 billions of miles from us, according to Auwers, about 40 billions of miles. Other values of the "parallaxes" of a few stars are given in most works on astronomy. I have here converted the values into miles for the ordinary reader.

I must repeat that it is only the *change of velocity*, that is the measure of acceleration acting upon a body. We cannot employ Kepler's third law, usually enunciated as "the squares of the periodic times are as the cubes of the mean distances," strictly, except for *circular orbits*, and, as Professor Marmol states, making allowance for the mass of the revolving body as well as the central one. If we consider that a comet moving in a *parabola* under the Sun's action has at *any point* a velocity $\sqrt{2}$ times that of a planet moving in a (nearly) circular orbit at the same distance from the Sun, we see this at once:

Taking his formula: $\frac{V^2d}{M}$ = constant, and putting

V_P for the planet's velocity, V_c for the comet's velocity, d = common distance, M = mass of Sun,

we have $\frac{V_c^2d}{M} = \frac{V_p^2d}{M}$, but $V_c^2 = 2V_p^2$ $\therefore 2 = 1$.

Quod est absurdum! as Euclid would say.

Till we know, with a reasonable approach to accuracy, the true velocity of our system referred to the stars, and till we can detect any change in it, either in magnitude or in direction, it is altogether premature to speculate as to the centre of its motion.

To assume that the Sun's orbit is a circle, as Professor Marmol virtually does, and then apply Kepler's law to an imaginary velocity, is beyond my power. As a matter of personal opinion, I think it is unlikely that the Sun's path is a *closed one*, from the enormous distances of even the nearest stars, but it must be curved in some degree, though it may be centuries before any evidence of this can be certainly ascertained.

With regard to Alcyone, quoting from memory, I believe that the reason Maedler thought it probable this was the "central Sun" of the Pleiades was because he found that of 60 stars in this group, whose proper motions he investigated, all *except one* moved in a manner corresponding to this. We now know also that the stars of this group have similar spectra, and, from their grouping in this particular region of the sky, there is no doubt that they form a connected system. As I neither know the mass nor the distance of Alcyone, nor the form of the orbits the other members of its system may describe about it, I cannot *calculate* these quantities; they must be determined as the result of *observation*.

F. W. HENKEL.]

London, S.W.

Answers to Correspondents.

John L. Dunk (Folkestone).—We are not aware of any such investigations; nor are we clear as to how such would be possible unless a telephone would be sensitive enough used as a detecting apparatus. The difficulty, of course, is that cooling and heating are produced in quick succession, and the average change in temperature is zero.

Linear Equivalents of Angular Measures.—It is impossible to convert angular measurements into linear values, feet, inches, etc., unless duplicate observations have been made at a second station sufficiently distant to introduce an appreciable variation in position of the object, or parallax, as it is called. If this is done, and the distance between the two stations is accurately determined, the equivalent of an angular measurement, as of a meteor flight, etc., can be easily found from the calculated distance of the object by a simple trigonometrical formula.

Vegetable Caterpillars.

By G. A. LAING.

THE so-called vegetable caterpillars in the accompanying photograph were brought from the neighbourhood of the Pink Terraces, New Zealand. Vegetable caterpillars are, or rather were, once real caterpillars, hatched from the eggs of a real butterfly, and lived their hungry caterpillar life devouring, among their fellows, the food plant chosen for them. When they dropped down to earth, on their road to bury themselves for their next change, they came across some new delicious food scattered over the ground, and eagerly snatched one last feast before they passed on their

Vegetable Caterpillars.

way. The new food was fungus spores, and every caterpillar that ate of them crept into its burrow with the seed of death within it.

Slowly, but by sure degrees, the poison spreads through the whole sleeping creature till it becomes hard and dry, and filled full of fungus—no longer an animal, but the root of a plant; a veritable caterpillar of wood. The change takes place so gently that the insect shape is quite unaltered. The rings of its body, its feet, its eyes, are all there perfect as in life, but never now will it transform into a chrysalis, and never now will out of it emerge a brilliant butterfly. For the fungus seed has been nourished on the body of its devourer, and out of the dead caterpillar's head shoots a long slender stem some 8 or 10 inches high, which by-and-by is crowned with fungus spores which ripen and fall ready to repeat once more the story with the next unwary caterpillar.

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Determination of the Light of the Moon.

MESSRS. J. STEBBINS and F. C. Brown have recently issued the results of their determinations of the relative intensity of the moon's light at various phases with that of a standard candle. They have used for this purpose certain types of sensitive selenium cells, one form consisting of two wires wound close together in a double spiral about a flat insulator, the spaces on one face being filled with selenium, which has been properly sensitized. An increase of temperature lowers the resistance of the cells, the change of resistance for 1° C. varying from 18,000 to 27,000 ohms. A Max Kohl standard candle was used, burning amylacetate, with diameter of wick 8 mm., and height of flame 40 mm. The sensitiveness of the apparatus will be evident from the fact that a ten-seconds exposure to the full moon produced a deflection of 160 mm. on the galvanometer scale. A correction is applied throughout for atmospheric absorption.

One of the most interesting results, shown in a curve reproduced in the paper, is that the full moon is approximately nine times as bright as the half moon. Another important point is that there is distinct evidence of the moon being brighter between first quarter and full, than in the corresponding phase after maximum. Although this was at first surprising, it is evident after some consideration that there are more dark areas on the eastern than on the western half of the moon's disc towards us, and in particular the third or south-west quadrant is brightest of all.

In the attempt to determine the candle-power, some uncertainty is introduced by an effect which appears to be due to selective colour sensitiveness of the cells. At full moon the candle-power is about 0.23 (*presumably at one metre distance*), as given by the mean of four cells. From their experience, the authors suggest that selenium cells give the most consistent results if short exposures are given, instead of the continuous exposures described by other workers, and that these results are at least as accordant as those from visual observations. With the aid of one of these selenium cells the central phase of a lunar eclipse was determined within one minute of the predicted time.—(*Astrophysical Journal*, Vol. 26, p. 326, December, 1907.)

α Andromedæ as a Spectroscopic Binary.

For some years past this star has exhibited peculiarities in the structure of its spectrum leading to the consideration of its being included among the spectroscopic binaries. From a series of measurements on thirty-eight plates, Dr. H. Ludendorff announces that he has determined the following elements for the orbit :—

U = 97·0 days.	ω = 70°.
V = − 14 km. per sec.	e = 0·4.
A = 34 km. B. = 26 km.	τ = 1904 Dec. 2.
u_1 = 98°.	α sini = 36,000,000 km.

(*Astronomische Nachrichten*, No. 4,220, p. 327, December 12, 1907.)

Return of Encke's Comet.

This well-known periodical comet, which has been observed at each of its returns since 1819, was first discovered at the present apparition by Professor Max Wolf, at Heidelberg, on January 2, 1908, in the position RA = 23h. 3m. 16s.; decl. = 1° 19′ N. It was extremely faint, about magnitude 13.0, so that it is not necessary to give a detailed ephemeris unless some increase of brightness be observed. The comet is passing through Pisces into Aries, setting near the western horizon about 10 p.m. Perihelion passage is computed to be about April 30, 1908.—(*Kiel Centralstelle Telegram.*)

Photographic Stellar Magnitudes on an Absolute Scale.

Messrs. J. A. Parkhurst and F. C. Jordan describe their determinations of various stellar magnitudes on an absolute scale, whereby the effect on a photographic plate of lights differing by a known ratio can be determined. Certain areas on the photographic plate are illuminated simultaneously by lights differing by a known ratio of intensity, so that the "time" element does not enter into the problem. A sensitometer box, eight inches long, and holding a 5 by 4 plate at each end, was fitted with 42 light-tight compartments running lengthwise, each cell being about 7 inches (18 cm.) long and 0.5 inch (13 mm.) square section. One end of this system of cells was closed by a metal plate pierced with a hole opposite the centre of each cell. This being uniformly illuminated, the amount of light passing through each cell depends on the diameter of the hole, and by suitably choosing these sizes it is possible to obtain a series of factors representing relative star magnitudes of the lights passing through each cell. The real star images to be measured are put out of focus so as to give small discs on the photographic plate, and then the densities of these patches are compared in a special microphotometer, with the scale of graduated densities constructed as above described. The lens used was a Zeiss doublet of 14.5 cm. aperture, and 81.4 cm. full length, most of the plates being 7 mm. inside the focal plane, giving images 1 mm. in diameter. For comparison, the results obtained with this apparatus have been discussed along with those of other workers by other methods. In the case of the Pleiades group, the results of Schwarzschild have been so compared, from which it appears that within certain limits, the agreement is very perfect, and the absolute method is capable of yielding results of extreme accuracy over a range of about two magnitudes on a single plate, and thus should be specially valuable for research on such light curves as those of variables of the Algol type. Reproductions of the photographs, showing the variations of R. Z. Cassiopeiæ are given; the whole of the light curve of this star was covered by eighteen extra-focal plates, with fifty-eight exposures.—(*Astrophysical Journal*, Vol. 26, p. 244, November, 1907.)

Position of Nova Persei.

Using the 40-inch refractor of the Yerkes Observatory, Professor E. E. Barnard has repeated his measures of the position of Nova Persei with respect to the neighbouring stars, and finds that, compared with the results for 1901-2, there is no evidence of motion. The present magnitude is about 11.6, which is apparently slightly greater than it has been for the last year or so.—(*Astronomische Nachrichten*, No. 4,220, p. 323, December 12, 1907.)

Sun and Planet Chart for 1908.

Messrs. Carl Zeiss send us the very useful chart prepared according to R. H. Bow, of Edinburgh. This gives on a single sheet, the positions of the sun and various planets during the year. The body of the chart consists of a star map. Beneath this is a chart of right ascensions, and near this, one of declinations. To determine the place of any planet on a given date, it is only necessary to read off its co-ordinates in R.A. and Decl. from these two latter charts, and apply it to the star chart, from which it will be at once evident how the planet lies with respect to the sun.

"Gazette Astronomique."

We are glad to welcome the first issue of a new monthly journal devoted to astronomical news, which has been published under the auspices of the Astronomical Society of Antwerp. An editorial article deals with the connection of Antwerp with historical astronomy, and very complete ephemerides of the sun and planets are given for the month. Various notes are added, dealing with items of recent interest, transit of Mercury, comet Daniel, Mira Ceti, etc.

BOTANY.

By G. MASSEE.

Phobochemotaxis of the Swarm-Spores of Myxomycetes.

THE chemotactic movement of the swarm-spores of the myxomycetes was first observed by Stange, who pointed out that the swarm-spores of *Chondrioderma difforne* and *Aethalium septicum* were attracted by certain organic acids, such as malic, valerianic and propionic acids, also by some of their neutral salts of alkali metals, but never by inorganic and certain organic acids such as phosphoric, tartaric, and citric acids. From the standpoint of the modern theory of electric dissociation, Stange's investigation did not indicate the active component in the respective solutions used in his experiments. Dr. S. Kusano has described in the *Japanese Botanical Magazine*, a series of experiments bearing more especially on the point last named, and has also extended our knowledge respecting the chemotaxis of other members of the myxomycetes. *Aethalium* proved to be the fittest material for experiment, as it furnished the most active swarm-spores within a short time after sowing the spores. In testing, the chemotactic action of solutions, the well-known capillary method devised by Pfeffer was used. At moderate concentrations it was found that all acid substances attract, and basic substances repel the swarm-spores; neutral substances have no action. The intensity of action is in proportion to the degree of acidity or alkalinity of the solution.

The attraction of mineral acids is stronger than that of most organic acids at the necessary equimolecular concentration. As a rule, a dibasic acid exerts more influence than a monobasic acid. The less dissociable or weak acids, such as tannic, boric, and hydrocyanic, show little or no attractive action. Twenty-one different acids were experimented with.

The author concluded, from experiments made, that the positive chemotaxis of swarm-spores of myxomycetes has a close connection with the acidity of the substance used, and further, that attraction must be attributed to the ion H, and repulsion to the ion OH. This conclusion is evident if we take, for instance, HCl, NaCl, and NaOH, for comparison. These are easily dissociable substances, and in dilute solutions there are fewest undissociated molecules, hence the action must be exerted by the existing ions. Na and Cl ions being proved to exercise no influence, it follows that the active components of the solutions of NaCl and NaOH should be H and OH ions respectively.

The responsibility of H ions for attraction or positive chemotropism is a highly interesting fact when we remember that H ions generally exercise a strong toxic effect upon most organisms.

New British Plants.

In the *Naturalist* (January, 1908), Mr. A. Bennett announces the discovery, in Yorkshire, of *Potamogeton pennsylvanicus*, Wild., a species not uncommon in North America and the West Indies. The specimens were found in a canal near Halifax, just where the effluent from a cotton-spinning mill enters the canal. So far as is known this is the first authenticated example of a Potamogeton being introduced to this country.

Mr. W. Bellerby also notes the discovery of *Sphagnum bavaricum*, Warnst., in a boggy district near Ellerbeck, in Yorkshire.

Prop-Roots of the Laburnum.

In certain kinds of trees, such as mangroves and screw-pines, also in low-growing plants, as species of *Stylidium*, the formation of prop-roots has become a fixed characteristic feature. In the case of the trees mentioned, the prop-roots furnish a much broader base and more fixed points in the soft slime in which such plants grow, and consequently offer a greater resistance to the strain exerted by wind and waves, than would be effected by a single thick trunk. These are examples of special adaptation to environment; when the tap-root and base of the trunk commence to decay, they are replaced by the prop-roots.

Dr. A. W. Borthwick has pointed out, in "Notes from the Royal Botanic Garden, Edinburgh," that the same kind of thing takes place in certain forest trees, where a damaged root-system is often made up for by the production of a number of strong, adventitious roots, often produced at a considerable height from the ground. This may occasionally be seen in *Robinia pseudacacia*. A striking example of the formation of root-props is furnished by a laburnum growing in the Royal Botanic Garden at Edinburgh, where two strong root-props, originating some five or six feet from the ground, firmly anchor the tree, and compensate for the decayed condition of the lower part of the trunk.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

A Radiation Test for Mercuric Chloride.

AN interesting method of detecting minute traces of mercuric chloride (corrosive sublimate) has recently been devised by Herren Kof and Haehn. It is based upon the fact that if a sensitive photographic plate be placed film downwards at a distance of 5 to 10 millimetres from the surface of a dilute solution of the salt, the subsequent development of the plate is retarded. By placing a narrow strip of glass across the top of the beaker containing the solution, that portion of the photographic plate covered by it is protected from the radiation, and it is possible, after sufficient exposure in the dark room, to obtain subsequently an image of this protecting diaphragm upon the plate. This action of the mercuric chloride solution on the plate may be prevented by adding common salt in such proportions that a considerable amount remains undissolved, an inactive double compound apparently being formed. If now, however, a solution of tin chloride be introduced, dissociation and reduction of the mercury compound begins, and the photographic plate is again affected, but with this difference, that an image of a diaphragm between appears as a positive instead of as a negative on development. The reaction is obtained with solutions containing from 0.01 to 6 per cent. of mercuric chloride, but not with a 0.001 per cent. solution. In comparative experiments, in which a beaker containing a 2 per cent. solution was covered with moist absorbent paper, it was found that the mercury salt volatilised at the rate of 0.000,000,011 gramme per square centimetre of paper in 30 minutes (the time after which the first faint reaction could be observed on a photographic plate). These values were found by saturating similar pieces of paper with solutions of mercuric chloride of known strength, and comparing the stains given by these, on exposure to sulphuretted hydrogen, with those given under the same conditions by paper exposed at a distance of 5 to 10 millimetres above the test solution. If a drop of a 0.01 per cent. solution be placed in a cavity in an object glass and the film of a plate exposed to its action at the distance stated for 24 hours in the dark room, the image of the drop will appear as a white spot upon the plate after development.

The Pigment of Marking-Ink Pencils.

The recent notorious case at the Central Criminal Court is perhaps the first occasion on which the nature of the pigment of a so-called marking-ink pencil has played an important part in a trial for murder. It will be remembered that a fragment of charred paper was discovered, on which were words written in the violet pigment of one of these pencils. At first the accused person denied that the writing was his, but expert evidence was given to show that, apart from the similarity of the writing to that upon a card admittedly written by him, the pigment upon the fragment was the same as that in words upon this card, and that of a marking-ink pencil belonging to him. The correctness of these conclusions was afterwards admitted.

Although the pigments in such marking-ink or indelible pencils at first sight appear to be closely similar, they will be found on closer examination to differ considerably in their shade of colour, and still more so in their behaviour towards chemical reagents. Speaking generally, they may be said to consist of an aniline dye-stuff, incorporated with a basic material such as graphite, kaolin clay, borax, &c. The nature of this basic material, and the proportion of the aniline dye-stuff will obviously influence the degree of resistance offered by the pigment to the action of dilute solutions of oxidizing and reducing compounds, and by following the course of the reactions under the microscope it is usually possible to distinguish between characters made with the pencils of different manufacturers.

Pencils of this kind are frequently used for marking linen, but are not nearly so satisfactory as a good marking ink. Some of those examined by the writer, have left very fugitive characters, which is not surprising, considering the known want of permanency of aniline dye-stuffs. Those containing a silver salt, however, in addition to a colour pigment, give a more lasting writing.

A New Form of Iodine.

In Mendeljeef's table of the elements, the number of forms in which they have been found to exist increases on passing from the first to the eighth group. Hitherto, however, no polymorphism has been observed in the case of the elements in the seventh group, which includes fluorine, chlorine, bromine, and iodine. The probability of different forms of iodine is suggested by the fact that the colour of its solutions is violet in some solvents and brown in others, but it has been left for Dr. Kurbatow to isolate a definite new form of the element. When a solution of iodine is evaporated at a low temperature, it forms dendritic aggreates of crystals, whereas at a higher temperature, it yields the characteristic rhombic plates. Sublimation of iodine, at temperatures not exceeding 47°-48° C., also produces the dendritic form, which appears to differ only in crystalline structure from the other form. No relationship could be established between the colour of a solution and the form of the crystals.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

Oval Bombs in Lava.

A PAPER on the Origin of the Pillow-Lava near Port Isaac, in Cornwall, was read by Mr. Clement Reid, at the meeting of the Geological Society on January 22. A sheet of pillow-lava over 200 feet in thickness occurs in the Upper Devonian strata around Port Isaac. The pillows are usually from 2 to 5 feet in diameter, but range up to 8 feet; masses under 1 foot are rare. The individual pillows are quite disconnected, though moulded on one another and adherent where they touch. Where three pillows approach there was an angular vacant space, subsequently filled with calcite, which is often altered into chert. Their mutual relations seem to prove that they were soft when deposited, but not sufficiently soft to squeeze into corners.

Each pillow shows internally a central vacant space or spongy structure, often as much as 2 feet in length. This is succeeded by a thick shell of exceptionally vesicular lava, which is followed by an outer shell of banded, more dense vesicular rock. The whole mass is so vesicular that it must have been very light.

The intimate association with fine-grained marine strata

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shows that it was probably the result of a submarine volcano. The lava seems to have been blown out into thick-walled bubbles, kept from touching each other by the escaping steam. The whole mass was for a short time in the spheroidal state, and though composed of a multitude of large plastic spheres, the sheet could flow like a liquid. This eruption seems to have been analogous to that of Mont Pelé, described by Drs. Tempest Anderson and Flett, except that it was submarine instead of subaerial. The word "pillow" has been applied to these structures, but they might be better described as oval or elongated bomb-like concretions, or simply oval bombs.

Niagara Gorge.

The erosion of the Niagara Gorge is again occupying attention, and was the subject of an illuminating paper by Professor G. F. Wright, in calculating the "Chronology of the Glacial Period in North America." The erosion of the Niagara Gorge probably dates from midway between the disappearance of ice from Northern Ohio and from Quebec. If conditions have been uniform, the age of the Gorge would be 7,000 years. As the Niagara Limestone is thinner at the mouth of the Gorge and the Clinton Limestone has dipped out of sight at the Whirlpool, there is nothing in the stratigraphy to indicate a slower recession in the past than the present. Moreover, nearly one-third of the erosion has been accomplished by two pre-glacial streams one from the south and a smaller one from the north. Therefore, Professor Wright rests with considerable confidence in the conclusion that the Gorge is less than 10,000 years old, and that the ice of the Glacial Period continued down to that time, to such an extent over the lower St. Lawrence Valley and Central New York, that it obstructed the entire eastern drainage of the Great Lakes. His impression is that the whole Glacial Period may well have been compassed within 200,000 years.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

Map-Studies of Rainfall.

DR. H. R. MILL, in his Presidential Address to the Royal Meteorological Society, dealt with the subject of "Map-Studies of Rainfall," and as he is the Director of the British Rainfall Organization, he spoke of his own work. He said that the special problem which he had before him was to determine the normal annual rainfall of the British Isles in relation to the general configuration of the land, and to ascertain how the rainfall of individual years and months, and even of the constituent showers, was related to the normal. The most useful method of working towards this end is by the preparation and study of maps of rainfall. He described the methods which he adopted in preparing annual, monthly, and daily maps of the distribution of rainfall, and also referred to cyclonic and thunderstorm rains. The rainfall showed an unmistakable relation to configuration. He pointed out that rainfall is not only the most difficult of all the meteorological distributions to map accurately, but it is also that one which is of the greatest importance—for by rain the rivers are fed, and the rivers both water and drain the land. Every year makes clearer the vast national importance of accurate knowledge of the rainfall of a county, for the problem of the rivers is becoming acute. The growing populations of the great towns are tapping the upper waters and diverting the water from its natural channels, and at the same time they are polluting the lower courses with the waste of the factories and the streets. Toll is taken all along the banks of industrial streams for raising steam and carrying on the multitudinous processes of manufacture. There is sometimes anxiety as to whether the waterways can be kept sufficiently supplied to float the water-borne traffic or to fight the silting action of the tides, and there is growing alarm as to the possibility of fish traversing the depleted and polluted streams to reach their spawning beds. Of recent years the value of the water power which may be generated in the lonely and lofty places amongst the western heights of Great Britain, where the rainfall is large and unfailing, has been recognised; and chemical works for the production in electric furnaces, of what a few years ago were rare substances, are becoming familiar features in Wales and the Highlands. In Ireland, too, the rainfall is an unrecognised source of wealth, which as yet has not been drawn upon to any appreciable extent.

The increasing strenuousness of the struggle for the possession of large water-supplies is producing in England, and especially in Wales, a great amount of local jealousy and strife, for the boundaries of parishes and counties coincide but rarely with water-partings; and the argument has been brought forward again and again that the rainfall of one county should not be diverted for the use of the inhabitants of another. The feeling is intensified when the boundary to be crossed is that of a historical division of national importance, like the boundary between England and Wales; but Dr. Mill thinks that the map-study of rainfall can do something to suggest the lines on which such disputes should be settled. Although the exceptional deluges of a thunderstorm or a great depression fall with equal and impartial heaviness on the hills of the west or the flat plains of the east, the common every-day rains are precipitated on the high lands and in the mountain valleys which cross the track of the prevailing wind in much greater abundance than on level and low stretches of country. Most of the rain is borne to our islands from the Atlantic and when it comes torrentially, it is of the air, and no boundary checks it; the largest annual falls come down on and near the watersheds, because there the land produces its maximum influence as a rain compeller. From the high ground the rivers seek the plains carrying off the excess of rainfall into the less liberally-watered districts. The Dee, the Severn, the Wye, and the Usk restore to England part of the rains which the Welsh mountains have abstracted as the air passed over them. The high rainfall of the whole Pennine district, sometimes by circuitous routes across the comparatively dry plains of the east, swells the volume of fresh water that pours into the Humber. The Thames itself receives the comparatively high rains of the Cotswolds, the Chilterns, and the Downs, and forwards the water slowly through less and less rainy districts, until it reaches the sea in the driest part of England. Thus, at least, as good an argument can be drawn from this consideration of physical geography in favour of supplying the great towns of the east from the large precipitation of the west, as can be drawn in the opposite sense from the artificial divisions of political geography. Therefore, care for the water supply of the country, coming as it does from the air that knows no bounds, across the land, is by no means a parochial, but, in the fullest sense, a national matter, and should be dealt with in the interests of the nation as a whole; the units of sub-division, when such are required, being the natural units of river-basins.

The Symons' Gold Medallist.

It was mentioned in the November number of "KNOWLEDGE," that the Council of the Royal Meteorological Society had awarded the Symons' Memorial Gold Medal for 1908 to Monsieur Léon Teisserenc de Bort, of Paris, "in consideration of the distinguished work which he has done in connection with meteorological science, especially the study of the upper air." The medal was presented to him at the annual meeting on January 15, he having come over from Paris to receive it in person.

Mons. Teisserenc de Bort commenced his scientific work in 1878 as a member of the staff of the Bureau Central Météorologique de France. He resigned his appointment in 1892, in order to devote himself to experimental research in Meteorology. In 1896 he founded an observatory for the study of dynamical meteorology, at Trappes, which has become famous for the boldness of its enterprise, and the success of its methods in the study of the upper air. He has also organized and directed for special purposes in connection with that study schemes for the exploration of the upper air in Denmark and Lapland, on the Cattegat, and the Zuyder Zee. He has transformed a Hull fish-carrier into a floating meteorological observatory, which, under the name of the yacht *Otaria*, has carried out—partly with

the assistance of Professor Rotch—extensive researches in the Mediterranean, and over the inter-tropical belt of the Atlantic Ocean. His earlier published papers include a magnetic survey of parts of Algeria, Tunis, and the Sahara, undertaken during his periods of leave while still attached to the Bureau Central; and, while head of the department, he contributed sixteen papers on the general circulation of the atmosphere, the distribution of the meteorological elements over the globe, and their mutual relations; and the distribution of barometric pressure at different levels In this connection it is sufficient to mention the introduction of the idea of "centres of action of the atmosphere," the relation of the anomalies of temperature and pressure; the charts of isobars for 4,000 metres level, showing general cyclonic circulation round each pole above the irregularities of the surface; and the analysis of vertical motion in cyclones and anti-cyclones; as important general results that constitute definite advances in our knowledge of the meteorology of the globe.

But M. Teisserenc de Bort is best known for his work upon the upper air, by means of *ballons-sondes* and kites. The equipment used was designed and constructed at Trappes, and the results obtained have added largely to our knowledge of the upper air. The establishment of the existence of a so-called "isothermal layer" at a height of about ten kilometres is largely due to the work of the observatory. The identification of the return anti-trade above the north-east trade wind; the structure of the intervening layer, and the comparison of the temperatures in the highest layers in various latitudes, which apparently show a gradient of temperature from the pole to the equator, instead of one, as might be expected, in the opposite direction, are scientific achievements of M. Teisserenc de Bort, in collaboration, as regards some parts of the work, with colleagues of various countries. With Professor H. H. Hildebrandsson, M. Teisserenc de Bort has recently completed a historical treatise upon "Dynamical Meteorology." The advances made in that subject by his personal exertions, and at his own charges, must always remain for future historians among the most original achievements of the present generation.

The Rainfall of 1907.

The popular opinion has been that the year 1907 was a wet one. The large number of records received by Dr. H. R. Mill from observers in all parts of the British Isles show, however, that the rainfall was very close to the average. From an examination of the rainfall map, it appears that the whole east coast of Great Britain had less than the average fall of rain, the dry strip widening towards the south, and including the south-coast as far west as Brighton. The extreme fringe of the west of Scotland, the Isle of Man, the Lake District, the coasts of Lancashire, Cheshire, and North Wales, the coast of South Wales, and the western horn made up of Cornwall, Devon, Somerset, and Dorset, were also drier than in an average year; and the dry belts of the east and west met in a narrow strip through Manchester, Sheffield, and Lincoln. In three small areas the rainfall was more than 10 per cent. below the average; these were in North Wales and the Wirral Peninsula, along the east coast from the Tees to the Wash, and in the east of Kent; but no station showed a greater deficiency than 13 per cent. The portions of Great Britain where the rainfall exceeded the average included nearly the whole of Scotland, the Pennine region, Wales, and the Midlands, with an extension southwards to the coast of Hampshire. Apparently only the parts of Scotland south of Oban and west of Edinburgh had an excess greater than 10 per cent.; and in England, except for a patch in the extreme north-west, there were only a narrow strip in the north Midlands and a spot in Hampshire which were as wet. It is rare to see local differences in the intensity of rainfall so unobtrusive as in 1907. In Ireland, only a little of the north-east had a rainfall which differed from the average by so much as 10 per cent. The rainfall of the north, of part of the west, and of a patch in the south-east, slightly exceeded the average; in the rest of the country it was slightly less than the average.

The general rainfall for the whole of the British Isles comes out as 1 per cent. above the average, which, for all practical purposes, may be taken as the average, exactly the same as in 1906. The year 1906 was generally considered to be dry and fine, because the holiday months were dry, and 1907 has generally been stigmatised as wet and wretched, probably because in most parts of the country, as in London, there were a great many days with rain, and, perhaps, because a larger proportion of the rain than is usual fell in the daylight hours. Both years, however, practically coincided with the average, a result that has never previously been recorded.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Luminous Owls.

A RATHER animated discussion has just been raised in some of the daily papers on the subject of Luminous Owls, which we are to believe are by no means rare, though hitherto unsuspected by most of us interested in ornithology. Sir T. Digby Pigott was the first to draw attention to the matter. In a long letter to the *Times* he described what he believes to have been a barn owl, which was seen careering about an estate near Cromer, emitting a light so powerful as to create the impression, when first noticed, of a lamp being rapidly moved about over the ground; when, however, it suddenly mounted to the tops of the highest trees this explanation was at once seen to be impossible, and the source of the light was accordingly attributed to the barn owl.

Sir Digby Pigott suggests that this light is a perfectly normal product, and is used by the bird to stupefy its prey when hunting by night!

There is absolutely nothing that would lend even a semblance of support to such a hypothesis in the organisation of the barn owl.

That the particular bird to which Sir Digby Pigott refers had become in some way luminous, is possible. The source of this light may have come from phosphorescent bacteria growing on rotten wood, or decaying animal matter; either of which could have become adherent to some of the bird's feathers, owing to their contact with the walls of the cavity of the hollow tree wherein the day was spent. Or this luminosity may have been due to a diseased condition of the oil-gland, whereby its secretion became abundantly increased, and so changed in character as to assume a phosphorescent appearance on exposure to the air. In short, such light is abnormal.

The Grey-Backed Warbler in Kent.

Mr. J. B. Nichols, in *British Birds* for January, 1908, gives a short account of a male Grey-Backed Warbler (*Ædon familiaris*), which was killed at Hythe, Kent, on July 15, 1907.

This makes the first recorded occurrence of this species in Great Britain; and an excellent photograph of the bird supplements the description thereof.

Sooty Shearwater in Kent.

A Sooty Shearwater (*Puffinus griseus*), according to *British Birds* for January, was shot at Dungeness Point, Kent, on October 14, 1907. Dr. N. F. Ticehurst, who makes the record, remarks that the bird was a male, by dissection, and is the first authenticated instance of the occurrence of this species in Kent.

Little Bittern in Inverness-shire.

A Little Bittern (*Ardetta minuta*) was picked up, according to the Annals of Scottish Natural History, 1907, near Inverness, on June 9, 1907.

A Rare Variety of the Redwing.

The Rev. Murray Dixon, in the *Field* (January 11), records the fact that on December 15 he shot a beautiful

variety of the Redwing, whereof the plumage was of a pale biscuit or fawn colour, but with the usual markings very pale and indistinct. The flank feathers, however, retained the usual orange-red colour.

Varieties of this colour are rare, but the Hon. Walter Rothschild has two similar specimens in his museum at Tring, and Mr. Frohawk, in the *Field* (January 18), remarks that he has also an example of this variation.

PHYSICS.

By PROFESSOR ALFRED W. PORTER, B.Sc.

Recovery of Selenium Cells after Exposure to Light.

THE changes of the resistance of selenium on and after exposure to light are not instantaneous. In some cases the cell must be kept in the dark for several hours before the resistance comes back to its original value. Professor Merritt has recently made observations on this recovery as influenced by the duration and intensity of the previous excitation. If C_0, is the normal conductivity in the dark, and C the value at any instant, and if $(C - C_0)^{-\frac{1}{2}}$ be plotted against the time, the curves of recovery are similar to those giving the *decay* of phosphorescence of sidot blende when $I^{-\frac{1}{2}}$(where I is the intensity of phosphorescence) is plotted against t.

It is this gradual nature of the recovery which was the difficulty in the early attempts to transmit rapidly pictures to a distance by the use of selenium cells. And it is this difficulty which has been overcome by Dr. Korn in his recent very successful experiments.

Quartz Mercury Lamps.

By the use of fused quartz instead of glass for the tubes of mercury lamps, much greater voltages, with accompanying increase in efficiency, may be obtained. Mercury lamps mounted in glass and intended to take 110 volts are over a metre long, and 3 or 4 cms. in diameter. If mounted in quartz a similar lamp would be only 8 cms. long, and 1 or $1\frac{1}{2}$ cms. diameter. To begin with, the column of light fills the whole of the quartz tube, but after a short time contracts to a narrow band, the light having now a slightly yellow tinge. Owing to the high temperature reached, the mercury vapour is at about atmospheric pressure. The efficiency is about a quarter of a watt per candle. The following readings were obtained at the Reichsanstalt: With an electrical pressure of 174 volts, applied at the terminals of the lamp, and a current of 4.2 ampères, the horizontal candle-power in a direction at right angles to the axis of the tube was 3,080; these numbers indicate an efficiency of .24 watts per candle.

Efficiency of Telephones.

According to M. Abraham, the best telephone does not transmit to the ear more than one-thousandth part of the energy which it receives from the line.

Triboluminescence.

In the *Comptes Rendus* for 1907 (1st half), M. Karl describes the preparation and properties of a series of bodies which possess, in the highest degree, the property of emitting light when rubbed (triboluminescence), and which exhibit almost no ordinary phosphorescence. These bodies are obtained by warming to about 1,200° for half an hour, mixtures of sulphide of zinc, and bodies of very different kinds, salts of manganese, silicic, and stannic acids, &c.

It does not appear certain that this phenomenon is due to bodies of definite composition. It is indeed likely that it arises from the presence of small quantities of impurities.

New Determination of the Metre in Terms of a Wave-Length.

MM. Benoit, Fabry, and Perot have recently made a new determination of the relation between a metre and the wave-length of the red ray of cadmium. The measure chosen was one made of invar, of U-form section, a beam of light being passed along the hollow. At the extremities were fixed half-silvered plates of glass, which were adjusted to absolute parallelism. On the upper faces of the glasses were traced divisions such that the distance between two traces was nearly a metre. This length was then evaluated in terms of the international metre. The distance apart of the glass plates was then compared with the wave-length of the red cadmium ray by aid of secondary standards of 6.25 cms., 12.5 cms., 25 cms., and 50 cms. in length by means of the optical methods of Fabry and Perot. By the same method they measured in wave-lengths the sum of the distances separating the traces on the glass plates. The results, reduced to the wave-length in dry air at 15° on the hydrogen thermometer under a normal pressure of 760 cms., were:—

1 metre = 1553164·13 λ.
1 λ = ·64384696 millionths of a metre.

ZOOLOGY.

By R. LYDEKKER.

A New Crustacean.

THE chief zoological event I have to chronicle this month is the discovery of an entirely new type of crustacean, from Australia, the announcement of which appears in the *Victoria Naturalist* for November last. *Koonunga cursor*, as the creature is called by its describer, Dr. A. Sayce, indicates not only a new species and genus, but likewise a brand new family, if not, indeed, a group of still higher grade. It inhabits fresh water in the neighbourhood of Melbourne; and its chief peculiarity seems to be that while possessing in a pronounced degree many of the chief characteristics of the stalk-eyed group, it lacks the one feature from which that group takes its name, having distinctly sessile eyes. It is thus, to a great degree, one of the so-called "missing links" of creation; organisms that, by the way, are, if I may use an Irishism, by no means so uncommon as once supposed. If stalked eyes be, as Dr. Sayce surmises, a primitive feature, and the sessile type a dirivative therefrom, the new Australian shrimp will apparently indicate an early stage in the line of development of the specialised offshoot. It should be added that three of these creatures go to an inch.

The Size of the Mammoth.

Popular superstitions are hard to kill; and if a showman advertised his exhibition as "The African Elephant Show," instead of "The Mammoth Show," he might, I expect, have some difficulty in meeting the charges of his printer. Yet the former title would be much more expressive, for, as Mr. F. A. Lucas has recently reiterated in our American contemporary, *Science*, the mammoth was a comparatively puny beast in comparison with the lordly African elephant. In fact, according to this well-known American naturalist, the height of the mammoth does not appear to have exceeded $9\frac{1}{2}$ feet; a stature easily beaten by some individual specimens of the Indian elephant, and altogether outclassed by its African cousin, which not unfrequently reaches 11 feet 4 inches, and may in some cases probably touch a dozen feet. Despite the insignificant stature of the mammoth, there were, however, giants in the old days which altogether eclipsed *Elephas africanus;* the American *E. imperator*, and the European *E. meridionalis*, having stood certainly $12\frac{1}{2}$, and possibly reaching the astounding height of $13\frac{1}{2}$ feet. In this connection I may take the opportunity of mentioning that the pickled rhinoceros, from Austrian Poland, referred to in my last notes, was accompanied by a mammoth; and also that while the hides of both animals were in a wonderful state of preservation, the bones had almost completely disappeared.

Early Man in Europe.

From Neanderthal, in Switzerland, as well as from several other Continental localities, such as Spy and Kropina, have

been obtained skulls or fragments of skulls, indicating a low type of the human species; so low, indeed, that some authorities regard them as representing a distinct species, the so-called *Homo primigenius*. These skulls form the subject of a recent memoir by Professor W. J. Sollas, in the *Philosophical Transactions* (vol. 199, p. 281, 1907), in which it is shown that there are no grounds whatever for regarding the Neanderthal man as a separate species. On the other hand, so far as capacity of his brain-box is concerned, he appears near akin to the Australian native of the present day. "The Neanderthal race, the most remote from us in time of which we have any knowledge," writes Professor Sollas, "and the Australian, the most remote from us in space, probably represent divergent branches of the same original stock. In that most important of all characters, cranial capacity, the two races are almost identical." This is of great interest in connection with the modern view, that native Australians are low-grade members of the Caucasian or European stock, instead of, as at one time supposed, half-bred oceanic negroes. That they should be represented in Europe during prehistoric times is thus just what we should expect; and their relations, the Veddas of Ceylon, and the Toalas of Celebes, apparently mark their line of march from west to east. The heavy brow-ridges and the deep inset at the root of the nose are features in which the Neanderthal race resembles the Australian. On the other hand, as Professor Sollas observes, the face of the Neanderthal man is peculiar. "The large, round, widely-open orbits [eye-sockets], the projecting, broad nose, the retreating cheek-bones, the absence of any depression beneath the orbits, the long face, and the low degree of prognathism [jaw-projection], distinguish it in the clearest manner from the Australian."

Papers Read.

At the meeting of the Zoological Society of London, held on January 14, Dr. W. A. Cunnington gave a description of an expedition to Birket-el-Qurun; Mr. O. Thomas discussed mammals from the Shantung Peninsula of Northern China; while Mr. F. E. Beddard described the anatomy of a certain species of frog. The present writer exhibited a very abnormally and handsomely marked leopard-skin, from the Deccan, India.

REVIEWS OF BOOKS.

ASTRONOMY.

A History of Astronomy, by W. W. Bryant, F.R.A.S. (London: Methuen, 1907; 7s. 6d.).—Mr. Bryant's History of Astronomy is a miracle of compression. It glances at prehistoric astronomy; and it embraces matters of astronomical research as recent as the suggestions made by Kapteyn and Eddington of a double universe of stars, and the paper read by Mrs. E. W. Maunder last year, on a suspected modification of sun-spot areas by terrestrial influences. The state of astronomical knowledge on any given subject, such as the Martian Canals, the Red Spot on Jupiter, the atmosphere of Venus, the distances of the stars, or the character of nebulæ, is so completely brought up to date that in some respects Mr. Bryant's volume resembles an encyclopædia of astronomy. That, however, is not its chief recommendation. Accuracy, though so difficult to a journalist, should be easy to an astronomer, and a statement of accredited facts would have been a task well within the reach of any conscientious investigator of the science. But that which is remarkable in Mr. Bryant's history, in its more modern aspects, is his discrimination. By discrimination, we imply not only the ability to reject what is merely tentative or plausible in astronomic speculation, but the selective power which gives to discoveries their proper importance and significance and assigns to them their right place and value in the history of the science. The objective reality of the doubled canals on the planet Mars, for example, may seem of overpowering interest, because of the appeal which their existence and its implications makes to the popular imagination; and it would have been easy to assign to them an amount of discussion entirely out of proportion to their importance among the great problems of astronomy. But Mr. Bryant rightly refuses to confuse astronomic and psychological problems, and reduces the space he has to offer the canals to its right dimensions. Several other questions of a similar, and some of a dissimilar, character, are similarly treated, and, taken as a whole, Mr. Bryant's discriminatory processes are beyond cavil. But there is always the danger in a book of this kind that what is important shall sometimes be treated with the same conciseness as that which is merely of interest. There is not room for everything; and there is not room sometimes for adequate explanations. From the general tenor of the chapters we may be permitted to surmise that the "general reader" is aimed at as well as the student who has familiarised himself with the chief problems of astronomy. If that is the case, then even the intelligent reader might complain that in a matter like the "aberration of light," a little too much has been taken for granted of his knowledge if not of his intelligence. This is, however, a solitary complaint. Mr. Bryant has completed a difficult task in a way that gives his volume a permanent value, and will give it a permanent place on many shelves. Not the least of its admirable qualities is the terse, epigrammatic, and even entertaining manner in which it is written.

Rapport Annuel sur l'Etat de l'Observatoire de Paris pour l'Annee, 1906. (Paris: 1907).—M. Loewy once more, in his capacity of Director, presents his annual report, from which we gather several interesting features. The three images of a star on the astrographic chart plates sometimes differ in appearance, though of an equal exposure, and, regarding this as evidence of variability, photographic surveys for the detection of variables and determination of their epochs and periods are contemplated. M. Nordmann, by the use of a set of quickly interchangeable colour screens, hopes to evade the difficulty often felt in stellar photometry caused by comparison of stars of different colours; in fact, this method has already proved a success in his hands, and he has begun to study also the varying atmospheric absorption of different stellar rays in a way somewhat similar to the bolometric method of Langley and others applied to the sun, with the interesting result that so far the absorption appears to go the reverse way, being much greater for the red rays than for the violet. We have already noted the share taken by the Observatory in the reductions necessary for the 12th Eros Circular. Annals belonging to the years 1891 to 1896 have been held back from publication, as it was necessary to husband the financial resources available, which have had to undergo exceptional strain in other ways, but which must first be devoted to current work. During the year 1906, however, it was found possible to issue the volume for 1891, and make considerable progress with that for 1892. When the six years are completed the whole of the re-observation of the Histoire Céleste will be available. M. Loewy has himself elaborated during the year a new method of determining division errors of great accuracy and rapidity, having felt the need of something less expensive and exhausting than the old methods. The new method is in course of application to new circles supplied for the meridian instrument "du Jardin." The same instrument has also been equipped with a new form of self-registering micrometer, a great improvement on the Repsold, inasmuch as it can deal with both elements (right ascension and declination) at any altitude, and has been proved by MM. Fayet and Gonnessiat to get rid of their relative personal equation and to minimise accidental errors. The report goes on to give the usual complete summary of the work done in each department and with each instrument during the year, the progress with the astrographic chart, the printing, the computation of ephemerides and similar matters, and papers communicated to the *Comptes Rendus* and elsewhere by members of the staff. We learn incidentally that at Paris, just as at Greenwich, a new minor planet was discovered on a plate some time after it was taken, which has so far eluded re-discovery. M. Bossert died during the year, after a long illness.

XUM

BOTANY.

Elementary Botany, by M. A. Liversidge (London, 1907: Blackie and Son, 1s. 6d. net).—This book differs from many others only in matters of unimportant detail, and would probably never have been published if certain antiquated figures had not been in existence. The information contained belongs to the Victorian age.

Laboratory and Field Manual of Botany, by J. Y. Bergen, A.M., and B. M. Davies, Ph.D. (Ginn and Co.; 4s. 6d.).—This book is of American origin and like many other American text-books, proves that morphology, tempered with physiology, are, as they undoubtedly should be, the stepping-stones to a correct knowledge of plants as living things. There is perhaps an excess of morphology, but it must be remembered that most of us are to a great extent the victims of circumstances, and swear by the conditions under which we exist. It must be admitted that morphology is a subject that can be met and prosecuted within the limited area, bounded by four walls, hence some of its popularity with teachers, and it too frequently happens in such cases, unless the teacher's personality and enthusiasm is dominant, the student simply becomes an expert manipulator. Granting an enthusiastic teacher, the book under consideration contains a mine of information on all matters essential to a thorough and sound introduction to those phases of botany it professes to treat upon. One important feature is the almost total absence of illustrations. This prevents bias on the part of the student, who as a beginner, can generally succeed in seeing under the microscope what is suggested by a figure that he should see. The authors are obviously more at home in the laboratory than in the field. In the section devoted to the "Study of Types of Seed Plants," many of the questions are too suggestive of the answer desired, a condition of things that cripples independent observation on the part of a student.

CHEMISTRY.

Theories of Chemistry, by Svante Arrhenius. Edited by T. Slater Price, D.Sc., F.I.C. (London: Longmans, Green and Co.; pp. xii. and 212; price 5s. 6d. net).—The artificial barriers that formerly divided one science from another are fast disappearing. The biologist, for instance, now studies the chemical reactions of physiological processes, while the chemist investigates the physical laws underlying chemical reactions. It is, however, in this relationship of physics to chemistry that the greatest advance towards union has been made. Isolated observations, that have long been accumulating, are now being built up into physico-chemical theories. Many of these support or supplement what we may still call the purely chemical theories of the old chemists, and, as Professor Arrhenius points out, "the new chapters in theoretical chemistry are a consequent and necessary continuation of the old science." In this book of fourteen chapters, consisting of a reprint of lectures before the University of California, the reader will find an admirable account of the recent development of theoretical chemistry by one who has himself contributed largely to that development. The modern theories of the composition of the atom and the nature of electrons, chemical statics and kinetics, electrolytic dissociation, and the development of the doctrine of valency are discussed at length, and it is clearly brought out how these views are the logical outcome of old ideas. Of course, some acquaintance with physics is demanded of the reader, who will otherwise be unable to follow the arguments.

NATURAL HISTORY.

Farm Live Stock of Great Britain, by Robert Wallace, 4th edition (Edinburgh: Oliver & Boyd, 1907; pp. xxxi. and 758, illustrated; 16s. net).—Since the present edition of this well-known volume has been rewritten and more than doubled in bulk, it may rank practically as a new work. As regards farm-stock properly so-called, that is to say, cattle, horses, and sheep, it contains a full and exhaustive account of all the better-known breeds, together with a vast amount of valuable information regarding breeding, feeding, and the diseases to which they are subject. Sheep-dogs being also included, the farmer will find it a complete manual on all matters connected with the whole of his four-footed animals. A special feature of the work is formed by the reproductions of photographs of prize and other examples of a large proportion of the breeds discussed. In all the above respects the volume is worthy of unstinted praise, and should prove invaluable to the farmer and stock-breeder. When, however, the author departs from his proper subject to discuss the descent and relationships of the so-called wild cattle of British parks, he soon gets out of his depth. In the first place, he appears to be entirely ignorant of the modern literature (both English and foreign) connected with the wild urus and these park cattle, and seems to think that Messrs. B. Dawkins and McKenny Hughes are the only writers on the subject. Familiarity with the natural history columns of the *Field* would have been sufficient to give some idea of the current ideas connected with these cattle. When he writes of *Bos longifrons* as a distinct species, his want of knowledge is at once revealed; while the statement (p. 27) "that the white of the wild cattle has no resemblance to the white of an albino—the dark points, which are universal, being incompatible with albinism," he writes what is neither more nor less than sheer nonsense. That park cattle are albinistic derivates from a breed akin to the modern Pembrokes, which are themselves not far removed from the urus or aurochs, the old wild ox of Europe, cannot be doubted.

PHOTOGRAPHY.

The American Annual of Photography, 1908 (London: Dawbarn and Ward; pp. 336 and numerous plates; 3s.).—Although entitled "American," this instructive and well-produced year-book contains a goodly number of English contributions from such well-known friends as Oliver G. Pike, F. J. Mortimer, and others. The predominant feature on the pictorial side appears to be portrait study, chiefly of children, and some very fine examples are given. The reading portion is of considerable value to beginners, and contains many practical articles which they will find written in a popular and interesting manner. On the whole, the volume reflects credit upon the Editor, Mr. J. A. Tennant, and it is to be regretted that, to our knowledge, there is no photographic annual (except, perhaps, "Photograms of the Year") published in this country to compare with the one under review.

The Half-Tone Process, by Julius Verfasser. (London: Iliffe and Sons, Limited, 1907; Fourth Edition; pp. 352; price 5s. net).—In preparing the fourth edition of this well-known text-book, the author has thoroughly revised it and added a few chapters so as to bring it up-to-date. That the work has been carefully done is obvious from the fact that the few misprints we noted are all duly corrected in a very short list of errata opposite the last page. The volume is a practical guide to the making and proofing of half-tone blocks, and includes in the first part a consideration of the studio, fittings, tools, and appliances, and in the second part the actual operations. The language used is concise and clear, and no theoretical matters are referred to except perhaps, to a certain extent, in connection with the cross-lined screen. The action of this is illustrated, showing how each aperture gives a pin-hole image of the diaphragm with a penumbra, as a guide to its intelligent adjustment. In this connection we would suggest that Figure 6a might with advantage take the place of Figure 5, with a suitable adjustment of the text, as the latter is incomplete in showing nothing of the penumbra that surrounds the point of light opposite every opening in the screen. The volume is well illustrated with regard to apparatus and also specimen results produced by screens of different rulings. As a practical hand-book, that leaves theory and history entirely alone, it is worthy of high praise.

POLAR RESEARCH.

Reviewed by Dr. H. R. MILL, F.R.G.S., &c.

Round About the North Pole. by W. J. Gordon (London: John Murray, 1907; 8vo., pp. xii. and 294; 15s. net).—Mr. Gordon may be congratulated on having achieved a very difficult task, for in the short space of 294 pages he has concentrated the leading facts of north polar exploration

into a readable book. He writes pleasantly, and the facts, limited and incomplete as their presentation must necessarily be, are not mis-stated so far as we can ascertain. If a reader totally ignorant of polar voyages were to take up this volume he would, we fear, find its plan somewhat confusing, for, like the much more detailed work on the same subject by General Greely, it deals with exploration according to the part of the Arctic circle attacked, and not in chronological order. The book is hardly scientific, and is not addressed to students, for, unlike Greely's, it gives no reference to the sources from which it is compiled, and by avoiding the incessant repetition of dates, which would have made it dull reading, it sometimes acquires a vagueness which detracts from its value. The illustrations are a special but a bewildering feature. As examples of the travesties of scenery and of the human form which our fathers and grandfathers had to put up with in books of travel, they are interesting enough, but there is no indication in the text that many of them are misleading or characterless if taken as representing things as they are. The summit of Oræfa facing p. 2 might be any ice-axe stuck in any heap of snow; the Samoyeds shown facing p. 10 are a singularly handsome and graceful people, but they are not the Samoyeds as the camera looks on them to-day; so, too, the drawings of ice are totally dissimilar to the photographs with which recent expeditions have made us familiar. A few of the portraits of explorers are excellent, but all the maps are poor sketches. Compared with such volumes as those of the World's Explorers series or the Story of Exploration series, in which known specialists treat their subjects critically and illustrate them by workmanlike maps and carefully chosen illustrations, this little book appears prodigiously expensive. When we are accustomed to receive about 400 pages of descriptive exploration for 4s. 6d. or 7s. 6d. by men of the reputation of Sir Albert Markham or Sir Thomas Holdich, it is surprising to find less than 300 pages by a less known author, less well illustrated, offered for 15s. net.

The Ziegler Polar Expedition, 1903-1905. Scientific Results obtained under the direction of William J. Peters, Representative of the National Geographic Society in charge of scientific work. Edited by John A. Fleming (Published under the auspices of the National Geographic Society by the Estate of William Ziegler, Washington, D.C., 1907; pp x. and 630, maps and plates; no price stated).—The results of the Ziegler expedition to Franz Josef Land in 1903-5 were, unfortunately, not in proportion to the lavish expenditure of money on an adventure which, otherwise planned, might have gone far to solve the North Polar problem. Results, however, were secured which are now set forth in the handsome quarto before us. We learn from the preface that the National Geographic Society in Washington selected the "Chief Scientist" of the expedition, Mr. William J. Peters, who was accompanied by two "assistant scientists," a weather observer and an assistant. The work done and now reported upon was almost entirely physical. A few words in the preface sum up the biological results, which consisted chiefly of the discovery of the Spitsbergen ptarmigan, *Lagopus hyperboreus*, which, not having been observed before in Franz Josef Land, is believed to have been blown over from Spitsbergen. Lignite of poor quality, but good enough to burn, was discovered at Cape Flora, but no systematic geological work is recorded. The volume falls into six sections, to which we allude *seriatim*. Section A, Magnetic Observations and Reductions, is the work of Mr. Peters himself, though completed by Mr. J. A. Fleming, of the Department of Terrestrial Magnetism in the Carnegie Institute at Washington. The observations were of a somewhat elaborate nature, and were carried out at Teplitz Bay in 81° 47′ N. for nine months, and at Alger Island in 81° 21′ for one month. Additional observations, chiefly of declination, were made in other places. An unlooked-for difficulty in the magnetic observatory at Teplitz Bay was the necessity of keeping firearms handy to protect the observers from inquisitive bears. The readings of the declination instrument were taken every two minutes for four hours a day, the period of observation being shifted so as to complete the circle of the clock in six days, and on one day each week the observations were kept up for the whole 24 hours. The observations at Teplitz Bay, printed *in extenso*, occupy 234 pages. The diurnal variation in declination is discussed with diagrams for each month, and the diurnal range is seen to increase distinctly from winter to summer, while the hours of maximum declination on either side of the mean fluctuate within somewhat wide limits from month to month. The maximum easterly variation from the mean occurred in December, the maximum westerly deviation from the mean in August. Inclination and horizontal intensity were treated much less fully, but altogether the magnetic observations showed a fine record of persevering work under hard conditions. The second section deals with observations on the aurora borealis by Mr. Fiala, illustrated by sketches, attempts to photograph the phenomenon having failed. The sketches were made with coloured chalk on sheets of black paper with a pinprick representing the zenith, and a circle drawn from that centre for the horizon. The paper was oriented by a compass and used as a plane-table, so that the position and direction of the light could readily be laid down. Mr. Fiala had had practice in rapid sketching, and he was able to reproduce the changing figures of the aurora in a very striking way. The best instance of this is a series of 10 plates showing successive appearances on January 23, 1904, from 9.36 p.m. to 10.28 p.m. The point whence the streamers radiated on this occasion was very near the zenith. Meteorology occupies the third section, the observations taken three times daily being given in full. Though valuable for the purpose of ascertaining daily range in particular months, these records were not continued long enough in one place to give an idea of seasonal change. As has frequently been noted by polar explorers, the thermometer was found to be of greater service than the barometer in giving warning of bad weather, a sudden rise of temperature being almost always accompanied by a severe storm. The next section details the tidal observations, and is written by Mr. W. J. Peters in conjunction with Mr. L. P. Shidy, the chief of the Tidal Division of the United States Coast and Geodetic Survey. Tide gauges were established at Teplitz Bay for two months, and at Cape Flora for three. The Teplitz Bay gauge consisted of a graduated staff attached to a line, one end of which was secured to a lead weight of 149 lbs. lying on the bottom of the sea, while the other end, after passing over pulleys on a stout wooden frame resting on the ice, carried a counterpoise weighing 40 lbs. By this means the line was always kept taut, and the graduated rod remained vertical and the same distance above the sea-bed, while the ice and the frame rose or fell with the tide. At Cape Flora an ordinary graduated post was set up on the shore. The observations were direct eye-readings taken at frequent though not regular intervals throughout the day and night. The observed heights of the tides were smoothed by plotting in curves, whence the heights at each hour were extracted and treated by harmonic analysis. The character of the tides in some respects were found to resemble those of the Pacific more than those of the Atlantic, but the authors conclude that they are Atlantic tides which reach Franz Josef Land by two routes, respectively east and west of Spitsbergen, the western wave reaching Teplitz Bay in the north of Franz Josef Land four hours before the eastern wave reaches Cape Flora in the south of the archipelago. Two short sections dealing with astronomical observations and the construction of maps complete the work, which is a solid if not very large contribution to our gradually increasing knowledge of the conditions of the Arctic regions.

MESSRS. PHILIP AND SON, LTD., send us two interesting and instructive maps, forming part of their "Imperial" Series, which are well printed in colours. On the one we have the World, showing physical features, winds and barometric pressure, annual rainfall, and regional vegetation, while the other is illustrative of the Polar Regions, and at the foot is an excellent chart depicting the annual mean ocean temperature for the whole of the world. They may be obtained, printed on paper and also on cloth with rollers, at reasonable prices, viz.: 2s. 6d. and 3s. 6d. each respectively.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page 22.*)

The object for ether freezing should be of a convenient size, say, a cube, three-eighths of an inch. It can be frozen without previous preparation, and this is very useful for work that needs to be done in haste, but crystals of ice form in the tissues and distort them, whilst the sections themselves are less satisfactory. Formaldehyde has been used with considerable success in this rapid section-cutting, but it is better to prepare the object in the following simple way: Make a solution of gum mucilage (B.P.), by dissolving 4 ounces of best gum acacia in 6 ounces of water, or use similar proportions. Prepare also a syrup by dissolving a pound of loaf sugar in a pint of water and boiling. This is Mr. Cole's formula. Place the object for 24 hours' in a mixture of 5 parts of the gum mucilage to 3 parts of the syrup. Remove the object from this solution, and remove the excess of solution from its surfaces with a cloth, put a little of the gum mucilage alone on the freezing plate and set the ether bellows going, place the object on the frozen mucilage upon the plate and with a camel-hair brush surround it with mucilage also. It will then be soaked with the mucilage and syrup, but surrounded with mucilage only. Work the bellows until the whole is frozen and then start cutting sections, re-adjusting the knife or object-carrier after each cut, removing the sections from the knife with the brush, and then transferring them to a small shallow glass vessel of distilled water close at hand. If the freezing is carried too far, they will cut badly, and splinter, or fly off; in that case stop the ether for a few moments. If the freezing is insufficient, the object will curl up, and perhaps shift. A little practice will soon make perfect, but the following hints may be of service. It may be difficult to freeze sections in a warm room. It will be necessary to add more mucilage from time to time. The blade must be kept cold, or the sections will stick to it. The sections sometimes roll if the saturating mixture contains too little syrup, in which case the tissues must be re-saturated accordingly. Better sections are generally cut when they are done rapidly. Very thin sections cannot be cut by this method, say, thinner than 15 or 20 microns (the micron is the one-thousandth of a millimetre). Sections that have been hardened in alcohol must have the alcohol removed by soaking in alcohol and water, of graduated strengths, say, 50 and 30 per cent., and then washing for a day in running water. Objects can, of course, be stained in bulk before cutting, or the sections can be stained afterwards. If stained in aqueous media they can be mounted at once in glycerine jelly, or Farrant's solution, or they can be passed through graduated alcohols and a clearing agent, for mounting in Canada balsam.

(*To be continued.*)

Royal Microscopical Society.

December 18, Mr. Conrad Beck, Vice-president, in the chair. Mr. J. E. Barnard exhibited some culture tubes of luminous bacteria, as well as large quantities in a solution, in a flask. The light given off by these bacteria was very evident when the room was darkened, especially when the flask was shaken. The light was nearly mono-chromatic, lying between the F and G lines of the spectrum. No heat could be detected, the whole energy of the bacteria being apparently utilised in producing light. Mr. Eustace Large exhibited, under microscopes, specimens of natural twin-crystals of selenite, illustrating by diagrams and models the method of preparation, and the effects produced by the varying angles at which the twin-plane cut the cleavage-plane. Mr. Large also exhibited, under special reflecing polariscopes, a number of artistic designs made from selenite, representing vases of flowers, flowers and fruits, parrots and chameleons, all of which changed colour in a most striking and beautiful manner when a mica film was rotated beneath them. Mr. Large further exhibited a small double-image prism of Iceland spar, which was mounted on an objective so as to give two images in complementary colours of a suitable object placed on the stage with a selenite plate. A paper by Mr. E. M. Nelson was read, on Gregory and Wright's microscope, described in 1786. Another paper by Mr. E. M. Nelson was read, describing a device proposed by the author, by which the object-glass of a telescope may be automatically rotated in order to always receive the rays from any part of the spectrum with obliquity. A paper by Mr. Jas. Murray described about 12 species of *Bdelloid* rotifers, from Old Calabar, Uganda, and Madagascar, including one new species and two new varieties. In the ensuing discussion, Mr. Wesché remarked that in the new species from Uganda (*Callidina pinniger*) the lateral appendages were very remarkable, and might be similar in function to the blades on the shoulders of *Polyarthra platyptera*, giving a sudden movement to the animal to enable it to escape danger.

Quekett Microscopical Club.

December 20.—Mr. J. I. Pigg, F.R.M.S., exhibited a series of photomicrographs of the development from the spore of the prothallus of the maidenhair fern. Mr. E. M. Nelson, F.R.M.S., communicated a paper on "Some Hairs upon the Probosis of the Blow-Fly." The hairs referred to were the minute spinous hairs upon the upper surface of the sucker, and the writer said that the visibility of the filamentous ends of these hairs is not only a test, but affords excellent practice in minute microscopical work. There are, in addition to these spinous hairs, other hairs equally minute, but pliant and soft. A third kind noted might be called giant hairs, for at the base they are five times thicker than the others are long. One measured .063 inch in length, and .002 in breadth, while a minute hair measures .00044 in length and .000036 in breadth. A fourth kind of hair found round the edge of the suctorial disc was described. These are forty times as long and ten times as broad as the minute hairs. They are tubular, with a flat flange on either side. One measured .0187 in length, and .00036 in breadth. Mr. E. F. Law exhibited a number of photomicrographic lantern slides in colour, taken on the Lumière Autochrome plates, of the oxidisation colours obtained by

heat-tinting on polished surfaces of metals. The metals used were phosphor-bronze, gun-metal, and various kinds of cast-iron. The magnifications employed were × 100 and × 1,000.

Cheshire's Apertometer.

Messrs. R. and J. Beck, Ltd., of Cornhill, have recently given me an opportunity of examining a new apertometer, which has much to recommend it. In consists of a brass case containing a thick disc of optically worked glass, with a series of concentric rings on its lower surface. It is only necessary to place the disc upon the stage of the microscope and to focus the objective upon a mark on its upper surface, then to remove the eye-piece, and, looking down the open tube of the microscope, to read off the number of rings which are in view at the back of the objective. Each ring corresponds to 0.1 N.A., and the rings are in sets of

five, in half-circles, to facilitate reading. By this means the aperture of any objective can be measured without any difficulty with regard to illumination, or any uncertainty as to the exact position of the pointers, as in the more elaborate and expensive Abbe apparatus. I can heartily commend this little instrument for its efficiency, simplicity, and, not least, for its cheapness, the price being only fifteen shillings. To assist in counting the rings with high powers, a special eye-piece can be obtained.

Microscopical Material.

By the kindness of Mr. S. C. Thrupp, of Haywards Heath, I am able to offer to those of my readers who care to apply for them, some moss capsules. Applications must be accompanied by a stamped addressed envelope, and by the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE." The mosses are *Polytrichum sub-rotundum* and *Funaria hygrometrica*, from Ashdown Forest, and *Polytrichum aloides* from Haywards Heath. I have distributed Funaria also on a previous occasion. It is well-known on account of its hygroscopic character, and can be mounted in a cell with a movable cover to show this. Of *Polytrichum aloides* and *P. sub-rotundum*, Mr. Thrupp says: "In the former the edges of the leaves are acutely serrated, and in the latter obtusely serrated; and in the first the capsules are longer in proportion to their transverse diameter than in the second, also the sections of the columella are different, being four-winged in the first, and circular in the second. The structure of the leaves in these two mosses is best revealed by sections across their axes. To detach the cap, boil in water for a few minutes, and then remove gently with needles, if necessary."

Notes and Queries.

H. T. E. (Queensland).—There is very little to choose between the one-twelfth-inch oil immersion objectives of the leading makers. Excellent lenses are made, for example, by Baker, Beck, Swift, and Watson, in England, and by Leitz and Reichert, abroad, or Bausch and Lomb in America. The price in all cases is the same, namely, £5, and I do not think it would be necessary for you to buy a more costly lens. You would be quite safe in ordering from either of the above makers, and I would suggest your getting an objective by the same maker as your microscope. I should prefer any of the above to the second lens on your list, whilst the third is more expensive than you probably require.

E. A. C. C. (Essex).—A half-inch objective is not high enough in power to enable you to study amœba, and you require at least a ⅙ inch. It is unfortunate that your ⅙ inch has so short a working distance, but you can get over it to some extent by using thin cover glasses. W. Watson and Sons have just computed a new ⅙ inch objective with a working distance of not less than a millimetre, which I noticed in "KNOWLEDGE" for last November. The material you mention should contain plenty of amœba.

W. D. (Sheffield).—Chromacetic acid is a good fixative, but is mostly used for fixing algæ and for embryological work. The formula is: Chromic acid 0.7 per cent., acetic acid 0.3 per cent., in water. A considerable quantity should be used—not less than 100 times—and it can generally be allowed to act for at least twenty-four hours. It must be thoroughly washed out in running water, and the specimens soaked in water for another twenty-four hours, with, perhaps, a change or two. A stronger formula would be chromic acid and glacial acetic acid, of each one per cent. Roots, rhizomes, stems, leaves, and even flower-buds, &c., are generally hardened in methylated spirit for a week or ten days, the spirit being changed each day for the first three days, and a considerable quantity used. If too hard to cut well they may be softened again by soaking in warm water or in glycerine and alcohol in equal parts. For very fine work methylated alcohol is, of course, unsuitable, as it shrinks protoplasm, and for such work absolute alcohol is better, whilst acetic acid counteracts to a great extent the tendency to shrink. A well-known formula is: Absolute alcohol 6 parts, chloroform 3 parts, glacial acetic acid 1 part. This penetrates well, and requires only a few hours, but must be well washed out in absolute alcohol. Unless alcohol is frequently changed it is advisable to suspend the object in it near the top, as the water and extracted matters sink to the lower strata. Fixation must be watched, and, if necessary, trial sections can be cut by hand.

Baker's Second-hand Catalogue.—Mr. Chas. Baker has sent me the January issue of his classified list of second-hand scientific instruments, which is unique in its completeness, and in the careful classification and description of its contents. The list before me contains no less than sixty-four pages, and includes all kinds of microscopes and microscopical accessories, objectives, etc., as well as surveying and drawing instruments, telescopes, and field glasses of all kinds, physical apparatus, photographic apparatus, surgical instruments, etc. Mr. Baker also makes special provision for the hiring out of microscopes and other instruments.

Botanical Apparatus.—Messrs. A. E. Staley and Co., of 19, Thavies Inn, Holborn Circus, E.C., the London agents of Messrs. Bausch and Lomb, send me an interesting catalogue of botanical apparatus, for use in plant physiology, mostly designed by Professor Ganong, including apparatus for the rotation of plants, and for the measurement of carbon dioxide and oxygen, light-screws, manometers, various apparatus for measuring transpiration, &c. Any reader who is interested in such apparatus can obtain a copy of the list on sending a twopenny stamp to Messrs. Staley, to cover postage.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas' Road, Cambridge, Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for February.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.43 and sets at 4.45; on the 29th he rises at 6.50 and sets at 5.36.

Sun-spots may occasionally be observed, though they are not very numerous; at the time of writing two small groups are visible on the disc.

The positions of the Sun's axis, centre of disc, and Heliographic Longitude, are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Feb. 5 ..	13° 35′W	6° 20′	259° 31′
,, 10 ..	15° 30′W	6° 37′	193° 41′
,, 15 ..	17° 16′W	6° 51′	127° 50′
,, 20 ..	18° 55′W	7° 2′	61° 59′
,, 25 ..	20° 24′W	7° 10′	356° 8′
Mar. 1 ..	21° 44′W	7° 14′	290° 17′

THE MOON:—

Date.	Phases.	H. M.
Feb. 2 ..	● New Moon	8 37 a.m.
,, 9 ..	☽ First Quarter	4 28 a.m.
,, 17 ..	○ Full Moon	9 5 a.m.
,, 25 ..	☾ Last Quarter	3 24 a.m.

OCCULTATIONS:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.	
			a. m.		a. m.		d. h.
Feb. 12	ζ Tauri	3·0	0 22	59°	1 19	298°	9 16
			p. m.				
,, 13	δ Geminorum ..	3·6	11 45	98°	1 0	279°	11 15
			a. m.				
,, 14	63 Geminorum ..	5·3	4 15	167°	4 36	211°	11 19

THE PLANETS.—Mercury (Feb. 1, R.A. 21h 46m; Dec. S. 14° 57′. Feb. 29, R.A. 22h 36m; Dec. S. 4° 49′) is an evening star in Aquarius, setting about two hours after the Sun, and thus fairly well placed for observation immediately after sunset until about the middle of the month. The planet is at greatest Easterly elongation of 18° 9′ on the 13th, on which date he sets at 6.53 p.m. Towards the end of the month the planet is unobservable, being in inferior conjunction to the Sun on the 29th.

Venus (Feb. 1, R.A. 23h 5m; Dec. S. 7° 14′. Feb. 29, R.A. 1h 8m; Dec. N. 7° 18′) is a brilliant object in the evening sky looking South-West shortly after sunset. On the 1st the planet sets about 7.50 p.m., and on the 29th about 9.20 p.m. The best time for telescopic observation is before it is quite dark, for later the brightness of the planet is in such contrast to the dark sky that the outstanding colour or secondary spectrum of most object glasses becomes detrimental to good seeing. In the telescope the planet appears gibbous about ·8 of the disc being illuminated. The planet will be in conjunction with the crescent Moon on the evening of the 4th, and with Saturn on the evening of the 10th.

Mars (Feb. 1, R.A. 0h 55m; Dec. N. 5° 58′. Feb. 29, R.A. 2h 8m; Dec. N. 13° 26′) is situated in Pisces and visible in the S.W. portion of the evening sky, setting about 10.45 p.m. throughout the month. The planet may readily be distinguished by his ruddy colour, but he forms a poor object in telescopes of moderate power, as he is diminishing in brightness and difficult to get sharply defined. The planet is in conjunction with the Moon on the evening of the 6th.

Jupiter (Feb. 1, R.A. 8h 44m; Dec. N. 18° 58′. Feb. 29, R.A. 8h 30m; Dec. N. 19° 49′) is a very brilliant object, being visible throughout the night and well placed for easy observation. About the middle of the month the planet is due South about 10.50 p.m., and on the 15th he is in conjunction with the Moon. The equatorial diameter on the 15th is 44″·6, whilst the polar diameter is 2″·9 smaller. In the telescope the attendant bright moons and belt markings on the planet's disc form interesting objects of observation.

The following table gives the satellite phenomena visible between 7 p.m. and midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Feb.				Feb.				Feb.			
1	I.	Tr. I.	11 35	10	I.	Tr. E.	10 5	22	II.	Sh. I.	8 58
	I.	Sh. I.	11 39		I.	Sh. E.	10 23		II.	Tr. I.	10 44
2	I.	Oc. D.	8 41	11	I.	Ec. R.	7 28		II.	Sh. E.	11 54
	I.	Ec. R.	11 5	13	II.	Oc. D.	11 26	23	III.	Oc. D.	9 25
3	I.	Tr. E.	8 21	15	II.	Tr. E.	8 28	24	I.	Tr. I.	11 14
	I.	Sh. E.	8 28		II.	Sh. E.	9 18		I.	Sh. I.	11 51
5	IV.	Sh. I.	8 2	16	III.	Ec. R.	11 29	25	I.	Oc. D.	8 21
	IV.	Tr. E.	11 12	17	I.	Tr. I.	9 29		I.	Ec. R.	11 18
6	II.	Oc. D.	9 12		I.	Sh. I.	9 57	26	I.	Tr E.	8 1
9	III.	Ec. R.	7 30		I.	Tr. E.	11 49		I.	Sh. E.	8 40
	I.	Oc. D.	10 25	18	I.	Ec. R.	9 23	29	II.	Tr. I.	10 6
10	I.	Tr. I.	7 45	22	II.	Tr. I.	7 48		II.	Sh. I.	11 34
	I.	Sh. I.	8 2								

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (Feb. 1, R.A. 23h 43m; Dec. S. 4° 8′. Feb. 29, R.A. 23h 55m; Dec. S. 2° 51′) is only observable for a short time after sunset, as he sets at 8.45 p.m. on the 1st and at 7 p.m. on the 29th. The ring, as seen in the telescope, appears to be nearly closed and we almost have an edge view; the Southern surface of the ring is visible at angle of only 2° to our line of vision.

Uranus (Feb. 14, R.A. 19h 6m; Dec. S. 22° 58′) is a morning star, rising about 6.20 a.m. at the beginning of the month.

Neptune (Feb. 14, R.A. 6h 54m; Dec. N. 22° 2′) is situated in Gemini about one degree North of the star ζ Geminorum. The planet is on the meridian about 9 p.m. near the middle of the month, and is practically above the horizon the whole night throughout the month.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Feb. 5-10 ..	5 0	+41°	η Aurigæ	Slow; bright.
,, 15 ..	15 44	+11°	α Serpentis	Swift; streaks.
,, 20 ..	12 4	+34°	Cor Caroli	Swift; bright.

Algol may be observed at minimum on the 11th at 10.30 p.m. and the 14th at 7.19 p.m.

DOUBLE STARS.—*Castor*, separation, 5″·6, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

ζ Cancri, separation 1″·1, 5″·1, mags. 5·5, 6·5, 7·5; with small telescopes the wider component is readily seen.

λ Orionis, mags. 4 and 6, separation 4″·5; pretty double.

σ Orionis, triple, mags. 4, 8, and 7, separation 12″·5 and 42″.

Clusters.—M 37, situated in Auriga, is one of the finest clusters, and very compact, its position is R.A. 5h. 46m., Dec. 32° 32′ N.